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FLYING

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Great Moments in

FLYING

by

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CHAPTER ONE

THE FIRST GREAT MOMENT

JUST after half past ten on the morning of 17 December 1903, a frail aeroplane of stick, canvas and wire lifted itself from a track laid on the sandy beach at Kitty Hawk in North Carolina, flew shakily for about twelve seconds, and then darted to the ground. Its forward speed was 7 m.p.h., which seems a rather feeble effort in our modern age of faster-than-sound flight, when jet-planes cross the Atlantic and return in a single day. Yet it was one of the greatest moments in all history, because it meant that the centuries-old dream of flying like the birds was beginning to come true.

The least excited of the small group of men at Kitty Hawk that day were the brothers who had conquered the air—Wilbur and Orville Wright. They were not even surprised at their success, because they had not simply rushed to build an aeroplane in the hope that it would fly. Instead, for three years, they had worked patiently and carefully to discover what made flight possible, and had then designed a machine based on the results.

They were a strange pair compared with many of the do-or-die would-be airmen who came before and after them. Sons of a bishop, they were quiet-spoken and serious, never taking chances, and quite certain that they would fly one day. Not for them the leather jackets and baggy trousers of a pilot. They were engineers, and when they flew they wore their usual smartly-creased business suits and white collars, although they did condescend to turn their caps back to front to avoid having them blown off.

Wilbur was the more forceful character, a lean, determined man who was kindlier than his thin-lipped set face made him appear. He had become interested in flying when he read of the achievements of the great German pioneer, Otto Lilienthal, who had made more than two thousand flights in his beautiful bird-like gliders before crashing to his death in 1896. Wilbur Wright realized that Lilienthal had been killed because he had not learned to control his gliders properly. In fact, all the early experimenters had been in too much hurry to get airborne.

If he were trying to fly, he would start by finding a fool-proof way of achieving 'balance' in the air. The rest could follow. He began watching the flight of buzzards, and it seemed that they kept their balance in a gusty wind by twisting slightly the tips of their wings. If they wanted to turn, it looked as if they twisted upwards the rear edge of one wing, and turned down the other. Without knowing it at that stage, Wilbur had discovered the secret of controlling the flight of an aeroplane.

He began to find it impossible to put the thought of flying out of his mind. As he worked with his brother Orville in their cycle shop at Dayton, Ohio, he talked more and more about the way the buzzards flew and how certain he was that he too could fly if he tried. Soon Orville shared his enthusiasm. They read everything they could about earlier experiments and began to design a glider.

But other men, too, were learning fast and, although it may not have seemed obvious at the time, the opening years of the twentieth century were to see an exciting race to be first in the air between the Wrights and Dr Samuel Pierpont Langley, secretary of the famous Smithsonian Institution.

In the year that Lilienthal died, Langley had built a big steam-powered model aeroplane that flew well over half a mile at 25 m.p.h. It caused a lot of excitement and

the U.S. War Department gave him $50,000 towards the cost of a full-size piloted version. An engineer named Charles Manly designed for this a remarkable 52 h.p. petrol-engine and was appointed test pilot for the first flight, which was to be made from a track mounted on a houseboat in the Potomac River.

Many early pilots preferred to make their attempts to fly over water rather than land, because they thought it would be 'softer' to crash into. It was just as well that Manly was one of them, because when Langley's aircraft, which he called the 'Aerodrome', was catapulted off the houseboat on 8 October 1903, there was a horrible grinding noise as the launching mechanism got tangled up with a guy-post, and the aeroplane simply toppled over the edge into the water.

Langley and Manly began preparing for a second attempt. But by then Orville and Wilbur Wright were also in the running. Their first glider, completed in 1900, could hardly have been more simple. With a wing span little more than that of Langley's model, it weighed only 52 pounds, and consisted merely of a pair of wings with a horizontal 'balancer' (elevator) in front and—most important—control wires which twisted the wing tips in the way that Wilbur had seen the wings of a buzzard flexing. The whole thing cost about £4 to build.

There was a space in the middle of the bottom wing, where the pilot could lie during flight; but the glider was flown most of the time as a kite, with the controls operated by cords from the ground. The flights were made at Kitty Hawk, which was the nearest place to their home town of Dayton, Ohio, that offered good steady winds and plenty of soft sand to fall on.

Tests with glider No. 1 were so promising that when Wilbur and Orville arrived home they began work at once on a second one. When completed, it had a wing span of 22 feet and weighed 98 pounds, which was very large for those days.

Hoping to improve the lifting power of the wings, they made them more curved than on the first glider, basing their design on the tables left behind by Lilienthal. To their surprise, when they got to Kitty Hawk in July 1901, they found that glider No. 2 was not so good as No. 1. They achieved a few minutes of free flight on most days, by getting two of the local men to push the glider for about 20 feet along the top of a hill to build up speed and then shove it over the edge, so that it glided down the slope. But the wings gave only a third of the expected lift, and it was obvious that Lilienthal's tables were not so helpful as expected.

This made life rather difficult, as they were by far the best tables that anyone had produced. So the Wrights decided they would have to start from scratch and design their own wings. At least they had the consolation of knowing that their warping wing control system worked and that their aeroplane was strong, as it had survived more than forty rough landings.

They began by fixing small models of different-shaped wings to a rig on the front of a bicycle, so that the lift could be measured as they cycled along. This did not work; so they made a wind tunnel from an old starch-box with the ends knocked out and with a fan at one end. With this, they measured the lift of more than two hundred model wings as the air flowed past them in the tunnel, and soon proved that Lilienthal's tables were far from reliable.

From this make-shift tunnel and home-made measuring equipment came data so accurate that, when the Wrights built their third glider in 1902 and took it to Kitty Hawk, they found that their 'lift' problems were solved. Unfortunately, the longer flights showed that their difficulties were not over, because when they tried to bank to the left, the aircraft often went to the right. It looked as if their wing-warping idea was not so bright after all, until they tried replacing the two rear fins of the

glider with a single rudder which was linked to the wing-tips so that it moved with them. This method of linking the controls was the most important idea the Wrights ever produced, because it formed the basis of most later aircraft control systems and earned them a lot of money.

Together with the forward elevator, it enabled the No. 3 glider to climb, dive, bank, and turn smoothly and easily, and they made nearly a thousand flights in the autumn of 1902, covering distances of up to two hundred yards. They had discovered how to fly. All that remained was to fit an engine.

This was easier said than done, because no engine on the market was suitable for powering an aeroplane. So Orville and Wilbur decided to make their own. The result was not so good as Manly's engine, although they did everything to make it as lightweight as possible. It gave 12 h.p., but they knew that their aeroplane, loaded with a pilot and fuel, would weigh about 750 pounds and that the engine would not lift it into the air unless they had a far better propeller than any yet built.

Success or failure, after three years of hard work, depended on that propeller. They turned to ship designers for help, only to discover that the methods used to work out the size and shape of a ship's screw were of no help to them. Gradually, they began to realize that an aeroplane's propeller has to work in the air in the same way as a wing. So they made the blades of their propeller like small curved wings and found that it was unbelievably efficient. To take full advantage of their discovery, they decided to fit two of them, driven by lengths of ordinary bicycle chain.

Back they went to Kitty Hawk, knowing that Langley, too, was preparing to fly a powered aeroplane. Still they refused to be rushed, and spent October 1903 improving their gliding skill. On 4 October they stayed up for 43 seconds. Twelve days later, Wilbur wrote in a letter: 'I see that Langley has had his fling and failed. It seems

to be our turn to throw now, and I wonder what our luck will be.'

For a time, it seemed as if that luck was against them, because the first time they tried to run their engine on the completed aeroplane, it backfired and twisted one of the propeller shafts. Stronger shafts were needed, and they had to be made at Dayton. They arrived on 20 November, only to give more trouble, and finally Orville himself had to dash home to make a set of even stronger shafts.

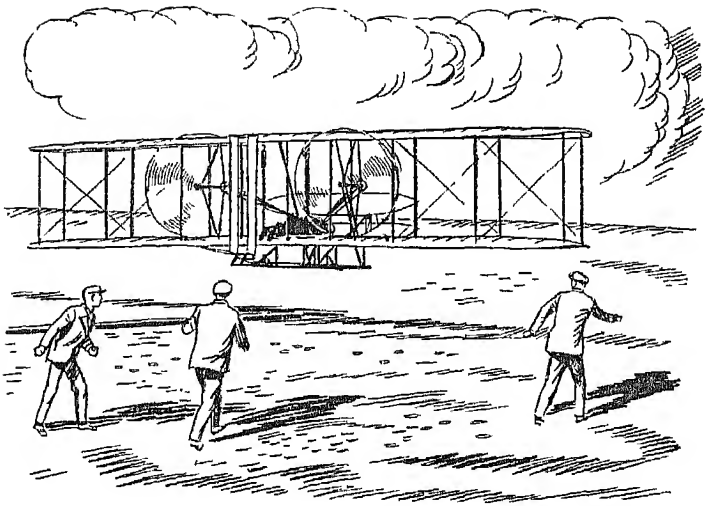
On his way back to Kitty Hawk by train, he read that Langley had again been able to test his aircraft before they were ready—and once more had failed. As on the first occasion the 'Acrodrome' had hit against the launching gear and dived into the river. Always ready to belittle would-be aviators, the newspapers treated the affair as a huge joke. A Boston paper commented that 'If Professor Langley had only thought to launch his air-ship bottom up, it would have gone into the air instead of down into the water'.

Heartbroken, and unable to afford further experiments, the old man gave up, and the coast was clear for Wilbur and Orville Wright.

Compared with Langley, they had been able to spend little on their aircraft. Orville reckoned that the total was under $1,000, even counting railway fares. The launching gear which had caused Langley so much trouble alone had cost nearly $50,000. The simple wooden launching rail which the Wrights laid on the sand for their aeroplane cost about $4.

On 14 December 1903, a small trolley mounted on two bicycle hubs was placed on this track, and the aeroplane was lifted gently onto the trolley. The two brothers tossed a coin to see who should be first to pilot their powered machine and Wilbur won.

Showing little of the excitement he must have felt, he lay on the lower wing, with his shoulders between the harness that controlled the wing warping, and opened



The frail aeroplane lifted itself from the track and flew shakily for about twelve seconds.

the engine to full throttle. The whole airframe shook and strained against the wire that held it back.

The wire was slipped and the aircraft began to lumber forward into the light wind. Too soon, Wilbur tried to get it into the air. Its nose lifted, then dropped, and the front elevator smashed into the sand.

Not for three days was it possible to try again. This time it was Orville's turn, and as the aeroplane began to move slowly forward into a strong 27 m.p.h. wind, Wilbur ran alongside, holding a wing-tip to balance it.

Suddenly, it rose into the air. Orville tried desperately to keep it level, but the front elevator was too powerful. With only a slight movement, it made the biplane rise to about 10 feet and as soon as Orville tried to stop the climb by turning the elevator, it made the aircraft dart towards the ground again. A sudden dive when

about 100 feet from the end of the track ended the first flight in history.

The distance covered was less than the wing span of an airliner like the Constellation or Britannia. The biplane had a top speed of only 31 m.p.h. and proved a dead-end design that was dropped after seven or eight years. But in those years improved versions of the Kitty Hawk biplane became the first aeroplanes to fly for half an hour and then an hour, at a time when no other aircraft in the world could achieve more than short ungainly hops a few feet above the ground.

The Wrights, in this moment of success on 17 December 1903, showed that achievement in flying depends on science as well as courage. They provided the inspiration that prompted men like Voisin and Blériot in France, A. V. Roe in England, and Glenn Curtiss in America to build and fly the better aeroplanes that finally made the Wright biplane as out-of-date as an old newspaper and yet the most treasured museum piece in aviation history.

CHAPTER TWO

THE COLONEL'S CATHEDRAL

THERE's an old saying that 'You don't have to be crazy to fly; but it helps', and certainly aviation has produced more than its share of unusual characters. None was more colourful than Samuel Franklin Cody, who had fought Indians in the Wild West before becoming one of England's greatest pioneers of flying. But let us start at the beginning. . . .

'Crazy' was the last word that anyone would have applied to Cody, even though he wore a goatee beard, flowing hair, cowboy hat and boots, and rode around the Army Balloon Factory at Farnborough on a richly-saddled white horse. It was realized that these were habits left over from his earlier life and, anyway, the superintendent of the factory himself used to take his wife shopping in a caravan towed behind a 10-ton traction engine, on which he loved to thunder through the streets of Farnborough.

Cody had been born on a farm at Birdville in Texas on 6 March 1861, in the heart of the Sioux Indian country. They were anxious days, because the warlike Sioux bitterly resented the white men invading their land and killing off the buffalo on which they depended for their food, clothes, and wig-wams.

No homes were safe, and one day it was the turn of the Codys. Without warning, the Redskins swooped down on the farm, shooting and burning everything in sight. Wounded, young Samuel Cody crawled through the nearby woods to Fort Worth, believing his parents had

been killed. They, in turn, believed him dead, and it was not until some years later that the three were reunited.

Meanwhile, Cody began to rival the deeds of his great namesake, Colonel W. F. (Buffalo Bill) Cody, who later became his firm friend. Hired to shoot buffalo to feed the men who were building railways through the prairies, he became famous in the west not only for his superb riding and shooting, but for his fearless courage and great physical strength.

As a change from buffalo-hunting, he joined in the gold rush to the Klondyke, without making a fortune, and then took charge of a herd of 3,275 cattle, which had to be driven across 1,300 miles of mountains, valleys, forests, deserts, swamps, prairies and canyons to Montana. Once again he found himself fighting off bands of marauding Indians, but he got the herd through, and the most serious wound he received in the west was from a drunken cowboy, who put a bullet in Cody's leg, where it stayed all his life.

Seeking a quieter life, he next began training and selling horses, which proved so profitable that he soon found himself in England, doing business with John Blackburne Davis, whose customers included King Edward VII. But his visits to the Davis home had other motives, and in due course the charming Miss Lela Davis became Mrs Cody.

It was no life for a timid person because, when Cody started touring America and Europe with his Wild West show, one of his favourite tricks was to stand his wife in front of an iron target, surround her body closely with a large number of clay balls, and then proceed to shoot the balls to pieces. But Mrs Cody had nerves of steel and could ride a horse and shoot almost as well as her husband.

Between his highly successful variety shows and melodramas, Cody began to devote more and more of his

time to a new hobby. As a boy, back in Texas, he had spent many hours playing with kites made by his father's Chinese cook. Now, he discovered that a number of young Army officers, both in Britain and on the Continent, were experimenting with large kites for military purposes.

Captive piloted balloons had been used for reconnaissance during battles for over a hundred years; but they were big, cumbersome affairs, and had to be accompanied by heavy carts carrying the equipment to make the gas with which they were filled. Obviously, it would be much more simple and less costly to lift a man into the air under a large kite, so that he could keep an eye on the enemy's movements.

After finding out as much as he could about kites already tested, Cody began making his own, and decided before long that they were good enough to give him his first experience of flying.

From the side of a hill in North London he sent up a string of large kites, tethered one above the other on a cable secured to a winch on the ground. He then clambered into a basket seat under the lowest kite, the cable was let out, and he was soon floating 80 feet above the ground. But not for long. A sudden gust of wind made the string of kites dart towards the ground, and Cody would have been killed if they had not ended up in some high trees.

The narrowness of his escape did not worry Cody, who at once set to work designing a kite that would not react so violently to gusty conditions. Soon he was ready for his second 'flight'.

This time, he first sent up a string of kites to a height of several hundred feet. Then he sat in the basket seat under a huge kite which he called his 'man-lifter' and which was so arranged that it could run up and down the cable on pulley-wheels. Control-lines from the kite enabled him not only to make it climb or descend, but, by warping the 'wing-tips', to fly straight and level.

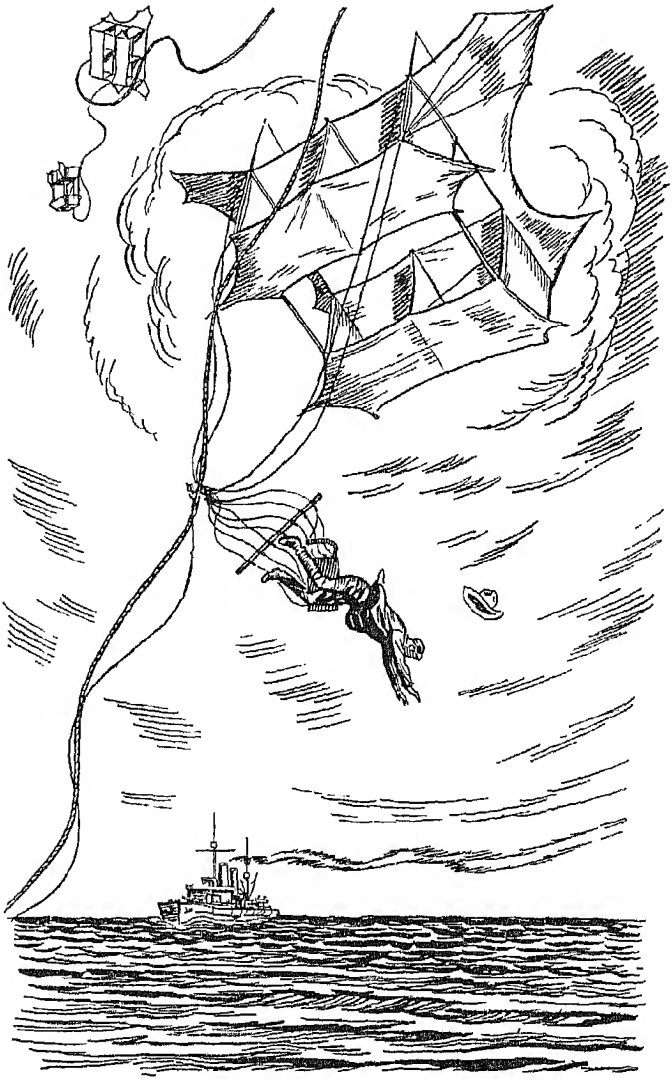
A brake on the pulleys stopped the kite at any height up the cable.

It was the first completely successful man-lifting kite in the world, and before long the Admiralty asked Cody to demonstrate it to them, first at Portsmouth and then from ships at sea. Even then, they realized the value of aircraft for reconnaissance, to give them a first sight of an enemy 'over the horizon', before their own ships could be spotted. Cody dressed up in his Sunday best to mark the honour they paid him. The result must have produced a number of raised eyebrows on H.M. cruiser *Grafton*, because he arrived on board in full cowboy rig, complete with an enormous stetson.

The trials went well. Cody was towed along under his 'man-lifter' about 800 feet above and behind the cruiser, as it steamed into wind. He was not unduly worried when the ship changed course through 90 degrees, although the resulting side wind meant that he floated to one side of the ship instead of behind it. When it made a further turn, to sail down-wind, he had no time to get worried. With no airflow to support them, the kites promptly turned turtle and began dropping towards the sea.

Fortunately, one of the men on the ship realized what had happened and cut the cable which tethered the kites to the winch. Instead of falling vertically, the 'man-lifter' began swinging to and fro, losing height much less quickly. When about 30 feet above the water, Cody dived into the sea and was picked up in due course by the cruiser.

The word 'fear' had no place in Cody's dictionary, and he wasted no time in resuming his experiments. His experience as a showman made him realize the value of stunts to attract public interest in a project; so he sailed across the Channel in a small canvas boat towed by one of his kites. Shortly afterwards, in June 1903, he won second prize in the International Kite Trials on Worthing



When he was about 30 feet above the water, Cody dived into the sea.

Down, which helped to earn him membership of the (later Royal) Aeronautical Society.

Even more important, his successes earned him a job at the Balloon Factory, Farnborough, where, with his sons Leon and Vivian, he perfected kites for military observation and photographic duties. The newly-formed Kite Section of the Royal Engineers used them with great success during the Army manoeuvres of 1904-5 and, in the following year, Cody was appointed Chief Kiting Instructor to the Army, with a workshop at the Crystal Palace.

He was, of course, still a civilian, and an American citizen, at that. So Army officers tended to get a trifle annoyed at first when members of the public, mistaking him for Buffalo Bill, called him Colonel Cody. But they gradually learned to love and respect the 'old man' (who was really only 45 years old), and when King Edward VII called him Colonel Cody, it was decided that what was good enough for a King was good enough for everyone else. He was always Colonel Cody from that day.

As early as June 1903, six months before the first flight of the Wright brothers, Cody realized that, because his kites were stable and controllable in flight, they might form the basis for a powered aeroplane. Two years later, he built a large glider on the same lines, with a wing span of 51 feet and movable control surfaces on the lower wings. It worked well and was flown without difficulty by ten different people on the day after its first flight. But Cody was kept so busy with his Army duties that he had no time to develop it.

On top of his other work, he was asked to help with the design of the airship *Nulli Secundus*, which made its first flight at Farnborough in September 1907. He was one of the three passengers, and later accompanied Colonel Capper, superintendent of the factory, on the airship's famous journey to London. Because of high

winds, it had to land at the Crystal Palace on the return flight, and the only way to deflate it was by ripping the gas-bag. So the Army decided to take the opportunity to rebuild it completely as the improved *Nulli Secundus II.*

Meanwhile Cody had been pleading with the War Office to let him build an aeroplane at Farnborough. At first he met with little success; so he simply fitted front elevators and a rudder to one of his kites, put in a 15 h.p. Buchet engine, and tested it as a pilotless model on Farnborough Common. It flew beautifully for 4½ minutes, and Cody was even more convinced that he could build a real piloted, powered aeroplane if given the chance.

Presumably even the War Office were slightly impressed, because they grudgingly allowed him a sum of £50 to build an aircraft to be known as British Army Aeroplane No. 1. They said nothing about an engine; so Cody designed the machine around the 50 h.p. Antoinette which he had brought from France for the now-dismantled *Nulli Secundus*. Inevitably, it took several months of argument to persuade the authorities to lend him this engine but, in April 1908, it was installed in the airframe which, like Cody himself, was huge and tremendously strong.

With its massive bamboo struts and the ordinary plough-seat which he fitted to save time and money, it weighed a ton, even without pilot and fuel, and its huge wings spanned 52 feet. The wires which braced the biplane wings were ⅛th inch in diameter and could normally be bent by a mechanic only with a couple of pairs of pliers; yet Cody knotted them with his bare hands.

Like the Wrights, he knew that his aeroplane would never take off unless it had efficient propellers. So, after he had fitted them, he tethered the aircraft to a tree near the balloon sheds at Farnborough by a rope with a spring balance attached to it. He then climbed on to the plough-seat, the engine was started, and he opened it

to full throttle so that he could measure with the balance the pounds of thrust developed by the propellers as they tried to drive the aircraft forward against the pull of the rope.

Today, the gnarled brown skeleton of that tree stands at the end of the 1½-mile concrete runway of the Royal Aircraft Establishment that has grown from the old Balloon Factory at Farnborough. Where a handful of girls once stitched fabric on the wings of Cody's aeroplane, now stand huge wind tunnels, a calculating machine that needs a building as large as a super-cinema to house it, and test rigs in which whole aircraft can be twisted and bent for days on end until they break, to prove their designs good enough for service in a supersonic age.

Yet Cody is not forgotten. His tree has become a shrine, enclosed with protective railings and bearing a plaque which records that: 'COL. S. F. CODY PICKETED HIS AEROPLANE TO THIS TREE AND FROM NEAR THIS SPOT ON 16 MAY, 1908, MADE THE FIRST SUCCESSFUL OFFICIALLY RECORDED FLIGHT IN GREAT BRITAIN.'

That first flight was really no more than a 50-foot hop, with the wheels a few inches above the ground, and was followed by four more, on one of which the Army Aeroplane rose to a height of 10 feet and covered more than 150 feet before touching down again. Then it taxied into a trough where men of the Royal Engineers watered their horses, and the wing spars were broken. To make matters worse, the Antoinette engine had to be returned so that it could be put into the new *Nulli Secundus II*.

Unfortunately—or fortunately, as it proved—this airship was not so successful as the first, and in due course, Cody was able to have back the engine. Meanwhile, he had made several changes to his aircraft, abandoning the original between-wings control surfaces in favour of warping wing-tips, which he had first used in 1901. After several trial hops, he made, on 5 October 1908, what was undoubtedly the first real flight by a powered aeroplane in Britain.

Describing it later to the Aeronautical Society, he said that he had become so annoyed by people who said that his aeroplane would only hop that he was determined to prove its true capabilities, even though it was underpowered and his 'airfield' on Laffan's Plain, not far from the Balloon Factory, consisted mainly of a hill with a clear stretch of only a quarter of a mile between clumps of trees.

'I went out', he said, 'with an easterly wind, left the ground at the bottom of the hill and struck the ground at the top, a distance of 74 yards. That proved beyond a doubt that the machine would fly, because it flew uphill.'

He turned round at the top and took off again, only to find himself heading directly for the trees. Overexcited, he misjudged the distance, tried to land before he got to them, realized he could not, and attempted to climb over them. His right wing just cleared their tops, with the left wing still over open ground—and Cody knew enough about wind currents to realize that this was not a good thing. Sweeping up over the trees, the 10 m.p.h. wind blew the right wing up and the aircraft began to cartwheel towards the ground.

The left wing tip hit the grass, but Cody managed to lift it again and all would have been well had not another clump of trees reared up in his path. He turned the rudder too far in a desperate attempt to miss them, dug in a wingtip, and the huge aircraft crumpled up like so much tissue paper. Once again Cody was lucky to escape with his life, and the fact that he had covered 496 yards at a height of 50-60 feet was some consolation for a wrecked aeroplane.

Fate struck a much crueller blow a few months later when the War Office decided that aeroplanes would never have any military usefulness and that they had wasted far too much money financing the experiments of Cody and his colleague at Farnborough, J. W. Dunne,

who built the first successful tailless swept-wing aircraft. In fact, they had spent a total of £2,500 at a time when Germany planned to spend £400,000 a year on military aviation.

It is difficult to say which was the greatest moment in Cody's life. It might have been the instant when he first felt his wheels clear of the ground in May 1908, or during his 496-yard flight in October. Perhaps it was later when, in an improved version of his aircraft, which had become known as the 'Cathedral' because of its vast size, he became one of Britain's best-loved and most successful sporting pilots, and a British citizen. Or in 1912, when, in yet another of his giant biplanes, he beat the finest aircraft that the French and British aircraft industries could produce in the important military trials on Salisbury Plain.

It was not really a satisfactory win, because nobody but Cody could fly his aircraft with complete certainty of ending up in one piece, and it was no use whatsoever for the newly formed Royal Flying Corps. But it was a popular victory, because everybody respected the colourful 'old man' whose giant aircraft was so well matched by his own great heart, courage, and strength. And when he was killed in the following year, Britain lost her best-loved airman.

CHAPTER THREE

OUR GREATEST PIONEER

By the side of the old motor racing track at Brooklands, and within a stone's throw of the vast aircraft factory in which the Vickers company builds jet bombers and turbo-prop air liners, there is a simple granite column, bearing a plaque that recalls one of the earliest of all great moments in British flying.

It was on 8 June 1908 that a young man named Alliott Verdon Roe trundled a fragile tail-first aeroplane out of a shed at Brooklands, started its engine, and crouched into the pilot's seat just forward of the lower wing.

He had been doing the same thing for many weeks; but this time there was a difference. As he moved forward over the concrete track, into the wind, he suddenly felt the machine lift into the air—not just the front wheels as in the past, but all four. He was flying for the first time and, in his own words, 'Those few seconds of life gave me a most exhilarated feeling of triumph and conquest, which more than repaid me for all my previous trials and disappointments'.

In fact, he had more trials and disappointments to come, one of the greatest being twenty years afterwards when a Committee of the Royal Aero Club met to decide who was the first British airman to fly in this country. They announced that Roe's 1908 hops were not long enough to count as proper sustained and controlled flights. Yet, despite that decision, there is not the slightest doubt that he was the greatest of all our British-born pioneers in the ten years that followed the first flight by the Wright brothers.

Like Wilbur Wright, A. V. Roe had started as a bird-watcher in the late 1890's. He was an engineer on the s.s. *Ichanga* of the African Royal Mail Company at the time, and his favourite relaxation when the ship was in South African waters was to watch the albatrosses gliding majestically overhead, with motionless wings.

They made flying seem easy; so he began building wooden models of an albatross and trying to make them glide along the deck. At first he succeeded only in amusing the rest of the crew. Then he became more adventurous and, instead of copying the graceful shape of the birds, he made models with biplane and triplane wings, or with wings one behind the other, and even tail-first designs.

Some flew quite well, and when he was at home between voyages he used to launch them into the garden from his bedroom window, then go down and collect them into a clothes basket, return to the bedroom, and start again. Often this went on all day, while he made small adjustments to the models to improve their performance.

As it happened, the house next door was a nursing home where slightly mental cases were accepted at times, and he was told some years later that one of these patients said to the matron, 'I'm sure this is a lunatic asylum like the next house, where a patient throws things out of the window all day long'.

Although he was already a skilled engineer, Roe decided that he would need to know more about designing before he could make any further progress, so he left the sea in 1902, when he was 25 years old, and became a draughtsman in the motor industry. In the following years he heard garbled reports of the Wrights' successful flight and was so delighted that he wrote to tell them about his own experiments. The reply he received was the last scrap of encouragement he needed to decide his future, and in

1906 he made up his mind to devote all his time to aviation, although the Wrights were still the only successful pilots in the world.

By one of those coincidences which prove that truth is stranger than fiction, the Aero Club happened at that moment to be looking for a new Secretary, and he got the job. To this day, he does not know why, because there were about a hundred other applicants for the job and he had no secretarial experience. His only qualification was that he wanted to build and fly aeroplanes, which could hardly have helped, as in 1906 the Aero Club was concerned only with ballooning.

In any case, it did not matter very much, as he remained there for only a very short time before being invited by a Mr Davidson to help with the far more exciting business of designing a helicopter. This resulted from a letter which he had written to *The Times*, in which he said that if serious experiments were started, he believed it would be possible to have a man-carrying aeroplane flying by the summer of that year. Apparently the Editor did not share his optimism, because when the letter appeared in the Engineering Supplement of *The Times* it was followed by the comment that, 'It is not to be supposed that we can in any way adopt the writer's estimate of his undertaking, being of the opinion, indeed, that all attempts at artificial aviation on the basis he describes are not only dangerous to human life but doomed to failure from an engineering standpoint'.

Considering that the Wrights were already flying for half an hour at a time, this was a rather remarkable attitude; but the Davidson helicopter certainly did nothing to change it.

Roe had to go to America to work on its design, and the more he saw of it, the less he liked it. Instead of being a simple, bird-like structure of the kind with which he had experimented, it was an enormous affair with two 30-foot 'rotors', each made up of 120 blades, and driven

by a pair of 20 h.p. steam-engines. Before it was completed, Roe returned to England to make the patent drawings. Later, he heard that some of the mechanics had started up its engine, at which it jumped off the ground and promptly fell back again with a thump that damaged its structure. This was more serious for A. V. Roe than for the future of aviation, because he found himself without a job.

Once again he was lucky, because the late Lord Northcliffe had decided it was time Britain became air-minded. Through his newspaper the *Daily Mail*, he offered a series of prizes, ranging from £250 for model aeroplanes capable of mechanical flight to £1,000 for the first airman to fly the English Channel and £10,000 for the first flight between London and Manchester within twenty-four hours.

It was just the kind of help that the struggling British designers needed, because few of them were rich men. But Northcliffe's rivals, who did not share his faith in powered flight, considered it merely a publicity stunt, and one of the evening newspapers sarcastically offered to give a *million* pounds to anyone who flew from London to Manchester.

Roe made up his mind to enter for the £250 model contest and set to work building three models at the home of his brother, who was a doctor, in Putney. When tested in the back garden, they all flew well, but his spirits were dampened when he learned in March 1907 that they would have to compete against more than two hundred other models.

The competition opened at the Agricultural Hall with an indoor display of the entries and, when he saw them, Roe could hardly believe his eyes. Nor could he understand the methods of the judges, because the Aero Club's gold medal went to the Short brothers for a ballooning exhibit and the silver medal to a Mr Tani for a wonderful contraption which included two electro-plated bowls,

some beautifully-polished clockwork wheels, and glass lenses, all shown under a glass case.

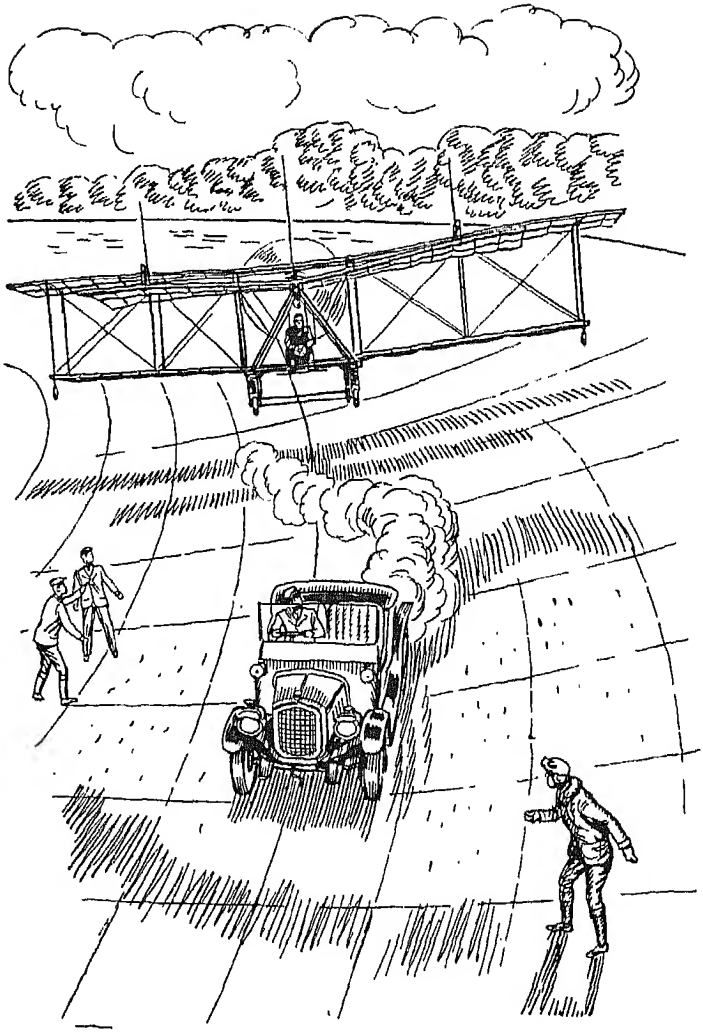
At least Roe had the strange consolation of knowing that none of these medal-winners would beat his models in the flying contest at the Alexandra Palace, for the simple reason that they could not possibly fly at all, let alone cover the distance of 100 feet required to win the first prize of £150.

In fact his own 8-foot span rubber-powered tail-first biplane was the only entrant to exceed 100 feet, and his other two models came second and third. But the judges were more interested in balloons than aeroplanes and, not realizing the work he had put into his models, decided he deserved only £75, and withheld the first prize.

Disappointed, but not discouraged, he decided to spend this money on building a full-size version of his most successful model and to have a shot at winning the prize of £2,500 which the authorities at Brooklands had offered to the first airman who flew round their race track before the end of 1907. Perhaps the manager hoped that nobody would win the money—because he proved anything but helpful, and it was only after a lot of argument that Roe was allowed to put up near the judge's box the shed in which he worked on his aeroplane.

The only engine he could afford was a 9 h.p. J.A.P., and he soon discovered that this gave insufficient power for anything but taxi-ing along the ground. But the motorists who came to practise on the track were more friendly than the manager, and often towed him into the air behind their cars, which proved at least that the machine was controllable in the air.

As a matter of fact, this was far more of an achievement than it might seem, because the only control surface was the front elevator, which was both warped and pivoted up and down by a single control column—the first time that two movements had been combined in a single column like the modern joystick.



Friendly motorists towed him into the air behind their cars.

Determined to fly, although it was now too late to win the £2,500 prize, and heartened by the offer on loan of one of the superb 24 h.p. Antoinette engines produced by Leon Levavasseur in France, Roe decided to live on about five shillings' worth of food each week and spend the rest of his limited cash on his experiments.

He considered it well worth while to exist on a diet of dates, kippers, bacon, and a weekly half pound of steak; but there was trouble ahead. When the motor racing season opened in 1908, he was ordered to move his shed to the paddock and paint it dark green, so that it would not be seen. As soon as he had done so, he was told that the green was not dark enough, and he was asked later if he would let the shed be used as an extra refreshment room. Forbidden to sleep in it, he used to say 'Good night' to the gate-keeper on the way out of the track each evening, and then climb back over the fence, so that he would be on the spot for an early start in the morning. This was essential, because it took two hours to get the aircraft out on to the track single-handed and two more hours to get it back, and there was trouble if it was still in sight when the first cars arrived.

Only by accepting such treatment cheerfully and overcoming the usual mechanical hazards, such as propellers that suddenly flew to pieces, were the pioneers of flight able to make any progress. Most people regarded them as a mixture of public menace and candidate for the nearest padded cell and, instead of feeling proud that history was being made on his track, the manager at Brooklands told Roe that he would have to leave soon after his first short flights on 8 June, 1908. If Roe had given up at this stage, it might well have been the end of the story, and there would have been no Avro 504 trainers on which to teach thousands of pupils to fly, including King George VI, or Avro Lancaster bombers to spearhead the R.A.F.'s offensive in World War II, or more than a hundred other Avro (A. V. Roe) types.

Fortunately, he did not give in easily, although he had also to return the 24 h.p. Antoinette engine that had been loaned to him for his biplane.

He still had his old 9 h.p. J.A.P. engine. So he built a remarkable little triplane with a wing span of 20 feet and covered it with cotton-backed yellow wrapping paper to save weight. When complete, it weighed only 200 lb. and it seemed possible that even 9 h.p. might be sufficient to lift this little machine off the ground. The difficulty was to find a place to fly it. The War Office refused to let him erect a shed and join Cody on Laffan's Plain and he was not allowed to fly from Wormwood Scrubs or Wimbledon Common. After studying maps of the whole London area, he decided finally to go to Lea Marshes, where he hired and boarded up a couple of railway arches to form workshops, and began the inevitable succession of hops and crashes, followed by one of his assistants on a bicycle, with a fire extinguisher.

His efforts brought one unexpected result in the shape of a letter from a young lady who had, apparently, made her way to the River Lea with the idea of drowning herself. Instead, she had seen Roe's triplane careering dangerously over the grass and decided she could end her miserable existence more profitably by taking his place and so, at least, saving one life. He replied that he would not like anybody else to try and fly the little triplane because it was tricky, but that he was working on an improved model which he might let her fly, and so she had something to look forward to after all.

On 13 July 1909, his years of patience and hard work were rewarded when he flew for about 100 feet. Two days later he repeated the performance, and the *Daily Mail* published a photograph of the tiny triplane in the air. No matter what the powers-that-be decided about his 1908 Brooklands flights, there was no disputing that those on Lea Marshes were the first by a British pilot in a British aeroplane, and for Roe it was the second of

many great moments in an aviation career that has continued to this day.

Unfortunately, it appeared that the flights were considered by some folks to be a nuisance. Among other things they disturbed the tramps who used to sleep out on Lea Marshes. But just before Roe was due to appear in court to answer the charges, a French pilot named Louis Blériot turned up unexpectedly in England and was given such a welcome that it no longer seemed a good idea to haul a British pilot into court merely for wanting to fly.

CHAPTER FOUR

FIRST ACROSS THE CHANNEL

THE arrival of Louis Blériot at Dover on 25 July 1909, was the first real indication that there might be a future in flying. The Wright brothers had been staying up for an hour at a time in their biplanes, but without getting anywhere; they needed a catapult to haul them into the air and were stuck if they landed away from their home base. A few other pilots had made short cross-country flights, usually in a series of hops between engine failures. But nobody had ever flown from one country to another across 22 miles of sea, and Blériot's success filled the headlines of the world's newspapers.

Not that there were any brass bands and bunting to welcome his actual touch-down on British soil—if 'touch-down' is the right way to describe a landing that smashed the undercarriage and propeller of his aircraft, and added a few more bruises to his already-bandaged foot. Yet the absence of a reception party was understandable. It was a new thing for foreign visitors to arrive by air, and certainly not to be expected on a gusty, rainy morning; because in those days pilots normally lit a cigarette before flying and stayed on the ground if there was sufficient wind to prevent the smoke going straight up.

Appropriately enough, the first person to arrive on the scene was a policeman, followed by the French journalist who was supposed to have found and marked a safe landing place. Next came a handful of curious, but not very excited, local inhabitants, and His Majesty's customs officer, for whom the event presented a major

problem. He had never had to record the arrival of an airman, and his official documents referred only to ships.

As Blériot was alone, it was fair enough to call him the 'master' of the craft in which he had arrived from France. So, as he apparently called the contraption his 'Monoplane', he was booked as 'Monsieur Louis Blériot, Master of the Monoplane'—and this is how we always remember him, though for a rather different reason.

Until Blériot came on the scene, most of the pioneers had experimented with biplanes, because this was the easiest way of making a strong girder-like structure. But he was more artist than scientist, and believed that aeroplanes ought to look like birds. So, as he had never seen a biplane bird, he was a monoplane man from the start. Today, we know that he was right; but the difficulties that faced him were enormous.

To start with, he was not a rich man, having made most of his money by inventing and producing motor-car headlamps at a time when there were not many motor-cars. This, and the unreliability of the aero-engines of the time, caused him to start with a tiny paper-covered aeroplane in April 1907. He called it the *canard*, which is French for 'duck', because that is what it looked like with its tail stuck out in front on a long 'neck'. It made only a few short hops, so he built a bigger, stronger machine, with two wings one behind the other like those of a dragonfly or, in French, a *libellule*, which is what he called it.

A gap of only two or three months between one aeroplane and the next, of entirely different design, was not unusual in the early days of flying. Nobody knew how to calculate the strength of a piece of wood needed for a wing spar or fuselage longeron, so the designers, who were also their own builders and test pilots, simply chose a length that looked about right and shaped it as necessary. It was an age of trial and error, with the possible reward

of a short hop if a pilot tried hard enough and the certain reward of a crash if he made too many errors.

This suited Blériot, who was an impulsive character. He built a lot of aeroplanes and had so many accidents that he earned a reputation for crashes even among the other French pioneers, all of whom had their fair share of trouble. Fortunately, aeroplanes flew neither fast nor high in 1907-8, when they flew at all, and were so fragile that they usually crumpled on hitting the ground. This saved their pilots from the full shock of a crash, and not many were killed.

Blériot progressed quickly from one aeroplane to the next. The *Libellule*, which had an Antoinette engine, brought his first successes, when he flew it 75 feet on 11 July 1907, and then 560 feet two months later. Like all his early machines, it was paper-covered and without any refinements such as undercarriage shock-absorbers; yet its controls were tremendously advanced. Instead of warping wings, it had separate wing-tips which were pivoted like modern ailerons. Nor was that all, for these ailerons and the elevators were both controlled by a single 'stick' in the cockpit, with a pivoted foot-bar to work the rudder, just as on a modern aeroplane.

Monoplane number VI was the most surprising of all, because its entire fuselage was covered to 'streamline' it. With its low wing, it looked more modern than some aircraft of twenty years later. Number VIII went back to an uncovered rear fuselage and high wing; but it was this aircraft that first made Blériot famous in France, by carrying him 8½ miles from the town of Toury to Artenay, and back, with two stops, on the day after the first-ever cross-country flight by English-born Henri Farman.

By then, Blériot was already weighing up the chances of winning the £1,000 prize offered by the *Daily Mail* for the first flight across the Channel, because he badly needed some more cash to continue his work. Unfortunately, 22 miles of water seemed wider than the Atlantic

at a time when 45 m.p.h. was considered fast and when aero-engines had a habit of getting so hot that they stopped after twenty minutes' flying. Nor was he the only airman interested in the prize for, when he arrived at Calais in July 1909, he found Hubert Latham and the Comte de Lambert were already there.

Latham was a particularly interesting character and certainly Blériot's greatest rival. A Paris-born Englishman, he had taken up flying because his doctors told him he had only one year to live and he thought he might just as well live it excitingly. From the start, he proved a superb and completely fearless pilot, and quickly became the idol of the air-minded French. Only 26 years old, he was eleven years younger than Blériot and no less venturesome.

Worried less about his new Monoplane number XI than about the unreliability of its 25 h.p. three-cylinder Anzani engine, Blériot decided to test it with a cross-country flight. Setting out from Chicheny, he managed to keep flying for 44 minutes, during which he covered the 25 miles to Croix-Briquet-Cheville. As this was further than the distance between Calais and Dover, he decided that the £1,000 prize was as good as his. But it was not, because Latham heard that Blériot was on the way and made up his mind to be first off the mark.

He, too, was a monoplane man, and the Antoinettes which he flew were among the loveliest aircraft ever built, with graceful wings and a boat-like fuselage of beautifully-polished wood. Like their engine, they were designed by the great bearded Léon Levavasseur and named after the daughter of his business partner. One of them can still be seen in the Science Museum's National Aeronautical Collection in London, together with Cody's Cathedral, Roe's 1909 triplane, the Vimy used for the first non-stop Atlantic flight, the first British jet-plane, and many other famous aircraft, which tell more of the bravery

and skill of flying's pioneers than can any library of books or faded photographs.

Latham, therefore, had no fears about his aircraft and success depended on whether he could keep its engine going for long enough to reach the white cliffs of Dover, which he could see clearly from the French coast.

Nothing was left to chance and, when he was ready to go, on 19 July 1909, wireless was used for the first time to obtain weather reports for a pilot. By 5.20 a.m. both Britain and France signalled that conditions were perfect, with a completely calm sea, no wind, and only slight mist which was disappearing as the sun rose. In the Channel, Léon Levavasseur himself waited on the French destroyer *Harpon*, which was to escort Latham and rescue him if anything went wrong.

Satisfied that all was as perfect as it could possibly be, Levavasseur ordered the firing of three guns at 6.16 a.m. as a signal to start. Within six minutes the Antoinette's engine was ticking over, and at 6.42 a.m. Latham took off, climbed to 1,000 feet in a wide, sweeping turn, and headed out to sea. Soon he was passing over the *Harpon*, her funnels puffing out great clouds of smoke as she steamed at full speed to keep him in sight. By contrast, he was floating through the air so peacefully that he decided to take a photograph of the boat. But just as he leaned over the side of the fuselage to focus his camera, the Antoinette's engine began to splutter and cough. Quickly he put away the camera and began checking over all the electrical connections that he could reach. They seemed to be all right, so, as the aircraft was now losing height rapidly, there was nothing he could do but alight on the water.

He did this so skilfully that he did not even get his feet wet, and when the *Harpon* arrived he was sitting calmly in the cockpit smoking a cigarette. Unfortunately, the Antoinette was very badly damaged by the tug-boat that hauled it out of the water, and Latham had

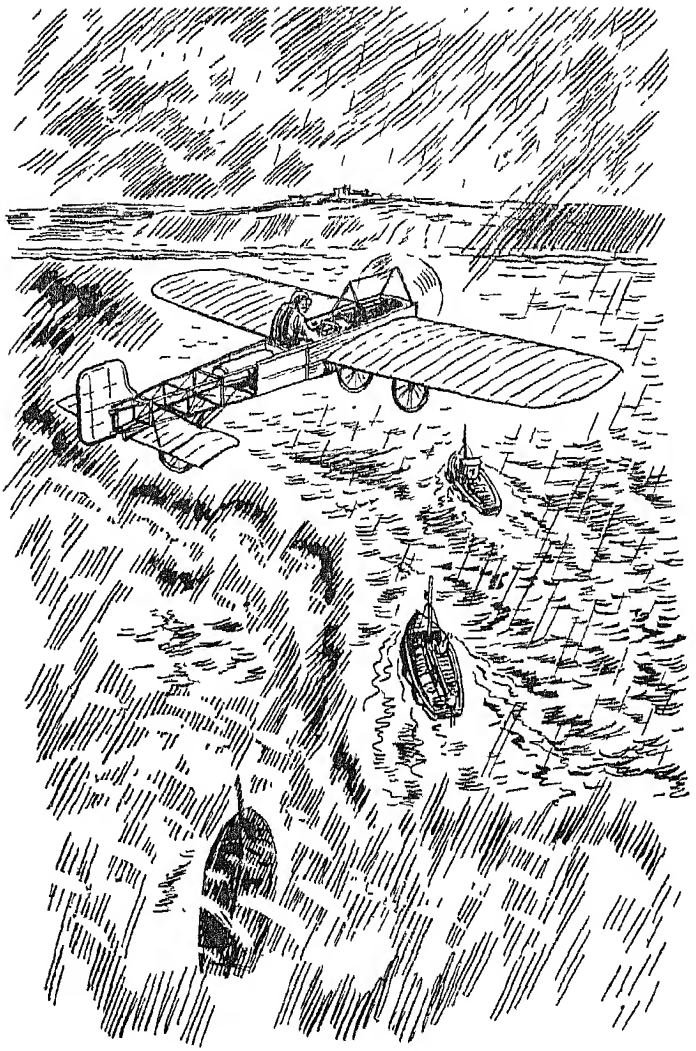
to wait for a new one to arrive from Paris before he could make a second attempt. By the 24th, both he and Blériot were ready and merely waiting for good weather.

Latham asked his friends to wake him early on the 25th. But when they went outside into a gusty wind they decided it was no weather for flying and let him sleep on. Even when they saw Blériot's monoplane being wheeled out and prepared for flight they thought he intended only to test it, especially as one of his feet was swathed in bandages following yet another crash-landing with his aircraft on fire a few days earlier.

Not until Blériot took off, his engine pop-popping at its full 25 horse-power, in the direction of England, did they realize the seriousness of their mistake. By the time that Latham arrived at where his aircraft stood waiting, it was already too late.

Blériot's departure had been typically impulsive and dramatic. He had hobbled up to his monoplane on a crutch, clambered aboard, asked a friend where Dover was, and then taken off in approximately the right direction at 4.35 a.m. Seldom more than a few feet above the water and without a compass, he had no worries at first because he could see the destroyer *Escopette* which was to act as his escort. Soon she was left behind, and Blériot found himself in a world of light, swirling mist with the sea below and nothing else in sight, not even a ship.

He decided to plod on in what he hoped was the right direction, quite unaware that he was being blown far off course by the wind. In about mid-Channel came the inevitable signs that his engine was overheating. It began to run more and more unevenly and the prospects of success seemed almost nil. He even flew into a shower which, at any other time, would have been about as welcome as tooth-ache. But this was different. As the rain beat on the engine, it sizzled off as steam, carrying



The wind and mist were still in control. Suddenly three boats came into view, seeming to be heading for a port.

with it some of the heat, and soon the little Anzani was running smoothly again on its new lease of life.

After he had been lost for about ten minutes, Blériot suddenly sighted the English coast about seven miles away. With anxious glances at his fuel gauge, and his ears straining against the cold air that whipped past his unprotected face, he flew on and on, looking in vain for his chosen landfall at Dover.

Let him tell the rest of the story in his own words:

'I flew towards this white mountain of coastline, but the wind and mist were still in control. My aircraft obeyed my instructions perfectly; but I could not see Dover. Suddenly, three boats came into view, seeming to be heading for a port; so I followed them meekly. As I flew down the coastline from north to south, the wind against which I was battling grew stronger. Then, just before Dover Castle, I saw a gap in the cliffs to my right, and felt an overwhelming joy. I flew towards it and plunged down. I was on the good firm ground again . . !'

It was 5.12 a.m. The wind had fought him to the end, gusting and eddying around the clefts in the chalk cliffs, making it impossible to control the little monoplane as it dropped onto the grassy slope of North Fall Meadow, in the shadow of the castle. But one more crash was nothing to Blériot compared with the achievement of being the first to link Britain and France by aeroplane.

To the £1,000 he received from the *Daily Mail*, there was added another £3,000 from France, and the future of his work was assured. He went on to break many more records, to open flying schools in both France and England, and a factory in which he built hundreds of monoplanes in the next five years. They were used for many great flights, including the first crossing of the Alps by air; and when the 1914-18 War opened, they were a mainstay of the tiny force of Royal Flying Corps

squadrons that laid the foundations of future greatness for the Royal Air Force on the western battle front.

Yet, no matter how famous and gallant were the achievements of the pilots who flew these aircraft, they will be forgotten long before that lonely 37-minute flight by Louis Blériot on 25 July 1909—the day that Britain ceased to be an island.

CHAPTER FIVE

THE GREAT ADVENTURE

It was June 1919. In the ten years since Blériot flew the Channel aviation had grown up. The frail stick-and-canvas aeroplanes of the pioneer days had given way to a generation of sturdy biplanes, built in tens of thousands for the first air war, and fitted with powerful, reliable engines.

Now that the war was over, the young men who had been trained to fly and fight longed to prove that the aeroplane was just as valuable in peacetime. They wanted to see it carrying great loads of passengers and parcels instead of bombs, to unite all the peoples of the world instead of destroying them. But first the world had to be made air-minded, and the trade routes of the air had to be opened up. Like Blériot, pilots began to look out over the water—not 22 miles of Channel this time, but nearly 2,000 miles of unknown skyways over the stormy Atlantic ocean.

Once again there was a *Daily Mail* prize to be won, for Lord Northcliffe had offered £10,000 to the first man who linked Britain and North America by air non-stop within a 72-hour period. Yet the real incentive was not money. The Atlantic flight promised to be one of the most exciting, hazardous exploits of all time, and there was hardly a pilot who would not have given his right arm for the chance to attempt the crossing in a suitable aircraft.

What was a suitable aircraft? One answer came from America, where the U.S. Navy was forming a special flight of big multi-engined Curtiss flying boats for the job. They had been designed to fly to Europe for war

service, via the stepping stone of the Azores, and that was the route the Americans still planned to follow. Nothing was left to chance. No fewer than 27 destroyers were to be spaced between Newfoundland and the Azores, each equipped with searchlights and signal rockets to assist the navigation of the flying boats' crews, and to provide an emergency rescue service. Five battleships, five cruisers and two tankers were to guard the second stage of the route from the Azores to Lisbon.

When U.S. Navy Secretary Daniels was asked by a journalist if he expected to beat the British, he snapped back: 'We hope to beat the world'. This was just the spark that had been needed to fire public interest in the race. It became a matter of national prestige and even the Air Ministry felt it could not ignore the challenge. Unlike the Americans, the Royal Air Force had two aircraft capable of making a non-stop crossing. The first was a monstrous triplane flying boat named the Felixstowe Fury, which had five engines and was even bigger than the Curtiss 'boats. When it crashed during a test flight, there still remained the airship R-34, if it could be got ready in time.

There were also, of course, the private fliers: but when the Royal Aero Club published the list of entries for the *Daily Mail* prize, it included such a motley collection of aeroplanes that they seemed to have little chance of success. Some had been built originally as wartime bombers and modified just sufficiently to give them a sporting chance. Half of them had only one engine. Yet this was not really a disadvantage. The aircraft with two engines had twice as many to go wrong, and certainly could not have stayed in the air carrying a heavy load of fuel if one engine had stopped.

Neither the U.S. Navy nor the Royal Air Force entered for the *Daily Mail* prize. So, at least, official competition could not rob the private pilots of the chance to win their £10,000 and, by May 1919, they were

beginning to arrive in Newfoundland, with their aircraft in wooden crates, prepared to set out on the greatest adventure in flying's short history.

They went to Newfoundland because they could be sure of tailwinds on the eastbound crossing. Few of the aircraft cruised at more than 90 m.p.h. or would have any fuel to spare on such a long journey, and one or two extra miles-per-hour might well have made all the difference between £10,000 and a watery grave. Unfortunately they soon discovered that nothing remotely approaching an airfield existed in the whole island.

Normally, this would not have mattered, because, in 1919, aeroplanes needed only a reasonably-sized field, clear of trees and cows, on which to take off and land. But these take-offs would not be normal. For example, the Atlantic biplane which the Sopwith company had built especially for the competition had a loaded weight of 6,150 lb., of which about half was fuel. With its single Rolls-Royce Eagle engine of only 360 h.p. (less than a quarter of the power of *one* of the four engines of a Viscount air liner) it could hardly be expected to hop smartly off the ground. Yet the best 'airfield' that its pilot, Harry Hawker, could find was an L-shaped piece of land, with legs 400 yards and 200 yards long, wrapped around two sides of a hill and with boggy patches to add to the fun.

Back in England, excitement mounted when it was known that the Sopwith Atlantic was assembled and ready to go. It seemed that Britain would be first after all, and even the weather appeared to be on Hawker's side, for the spring sun shone brightly. Soon, people began to get impatient. Hawker was one of the most daring test pilots in history, certainly not a person to waste time and let his rivals beat him; yet for several weeks there was no news from Newfoundland. The island's fogs were not so well known then as they are now, and as Hawker himself looked out day after day on their

grey blanket, he must have begun to regret his choice of take-off point.

His old friend Freddie Raynham arrived with a Martinsyde biplane, and soon there were two aircraft waiting for the fog to clear. Like true sportsmen, the pilots agreed not to steal a march on each other, but to give two hours' notice of their intention to take off, so that the other would have a chance to make a race of it.

Still the fog held them up, and two more aeroplanes arrived. One was a massive four-engined Handley Page V/1500 bomber, built originally to bomb Berlin from bases in England; the other a twin-engined Vickers Vimy bomber, which was to be flown by a young pilot named John Alcock. When the U.S. Navy flying boats also arrived on the scene, Hawker and Raynham knew that it was time they made a start, even if it meant flying partly blind.

On Friday, 16 May, the Curtiss 'boats left for the Azores, assured of reasonably good weather on the southerly route. The outlook was desperate for the British pilots, whose one ambition was to be the first across: but they could do no more than make test flights on the 17th; and that evening they heard that the Americans had reached the Azores. Only later were they to know that, of the three flying boats, NC-4 alone had arrived on schedule. NC-1 had come down in the sea 200 miles short of the Azores and had been abandoned by her crew. NC-3 had alighted to try to ride out the night so that her position could be fixed accurately next morning. In doing so, she was so badly damaged that her crew had to taxi 200 miles through choppy seas with a leaking hull, to Ponta Delgada, where they were taken off completely exhausted by their ordeal.

All that mattered to Hawker and Raynham was that their rivals had completed the first stage of the journey.

They *had* to leave next morning, fog or no fog, and might yet reach England first, because their aircraft were faster than the flying boats.

The weather was a little better at 3.40 p.m. on Sunday 18 May, when the overloaded Atlantic began to trundle diagonally across the L-shaped airfield. On and on it went, slowed by the hill, seeming as if it would never unstick. With inches to spare, Hawker cleared the ditch which ran across the foot of the hill and began climbing slowly towards the Atlantic.

Over the coast, Hawker pulled a trigger in the cockpit and the whole undercarriage fell away. Lightened and with less air resistance, the aircraft immediately began flying 7 m.p.h. faster, up through a small belt of fog and into the vast emptiness of the Atlantic sky.

For several hours everything went perfectly, with the engine ticking over as sweetly as a sewing machine and with a fine steady 105 m.p.h. 'on the clock'. Hawker's navigator, Lt. Cdr. Mackenzie Grieve, had no difficulty in working out the course to Ireland and the approaching night held little fear. Slowly, the blue turned to purple; but instead of a clear sky full of stars, the air became hazy and thick. They saw towering clouds ahead and their spirits slumped a little, although it was warm and comfortable in the cockpit.

Soon, the little biplane was being tossed around in the clouds. Slants of rain splashed over it and Mackenzie Grieve found navigation almost impossible. Hawker veered slightly to the north, hoping for more wind and clearer skies, but the clouds got thicker than ever.

At about 11 o'clock, he glanced at the temperature gauge of the water that cooled the engine and his heart missed a beat. It was much higher than it should have been and, even when he opened the radiator shutters to drive more cold air over the water, its temperature did not go down. Unable to climb over the masses of storm-cloud, for fear of using up precious petrol and mak-

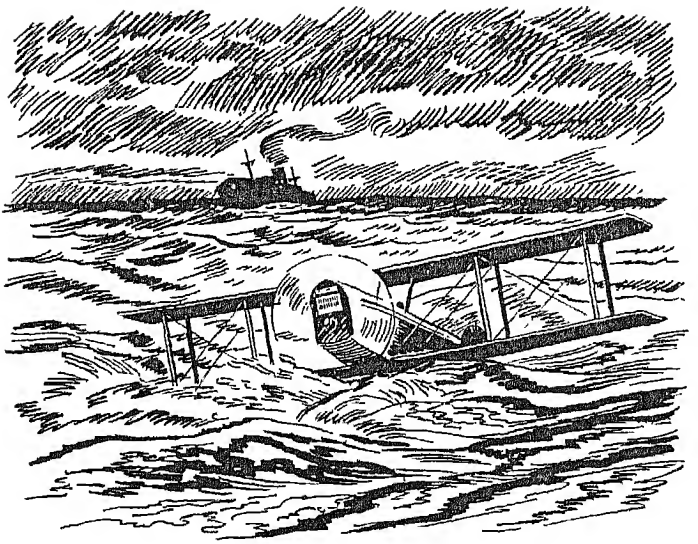
ing the radiator water boil away, he could only bump through and around them.

Still the water temperature rose, and Hawker guessed that a collection of rust and odds and ends of solder inside the radiator was blocking the filter, so that the water could not circulate properly. In an effort to clear the blockage, he switched off the engine and went into a steep dive from 12,000 to 9,000 feet before opening up again. It worked; but he knew that he could not do that sort of thing too often without running out of petrol; and an hour later the temperature was higher than ever, although the air through which they were flying was almost at freezing point.

Every time he tried to gain a few feet of height, steam began spouting from a tiny hole at the top of the radiator and soon the top wing was covered with ice. Yet it seemed that they might still succeed; for they were at 12,000 feet, could see the stars often enough to check their course, and were able to keep the water temperature just below boiling point. But their luck was out. At six o'clock in the morning, they found a bank of solid cloud 15,000 feet high blocking their path. Unable to climb over this without boiling away all the water Hawker shut off the engine and dropped to 6,000 feet. There it was blacker than ever; so they glided on down and down until they were only 1,000 feet over the water.

Then came the biggest fright of all, because the engine failed to re-start when Hawker opened the throttle. Mackenzie Grieve began pumping petrol furiously into it. Nothing happened, except that the Atlantic got nearer and nearer. Soon they were only 10 feet above the stormy sea and Hawker yelled to Mackenzie Grieve to hang on tightly because he would have to 'ditch'. At that moment, the engine opened up again.

They climbed back to 1,000 feet; but all hope of success had now gone, because it was obvious that the remaining



Hawker made an incredibly smooth touch-down on the water ahead of the ship.

water would boil away within an hour or two. So they began looking for a ship, and all the time the air became more bumpy, the sea more rough, and the rain showers heavier.

They had, at least, the consolation of knowing that they were on the main shipping route; and the designer of the Atlantic had built into the top of its fuselage a sturdy lifeboat, well stocked with flares and food. The absence of an undercarriage would also help them to ditch smoothly without overturning.

Suddenly a hull loomed up out of the fog. Shouting for joy, Hawker banked around it, firing signal rockets until he knew they had been seen, and then made an incredibly smooth touch-down on the water ahead of

the ship. They clambered into their little boat; but the rising seas prevented their being picked up until an hour and a half later, 14½ hours and 1,400 miles after they had set out so full of hope from Newfoundland.

Nor had Raynham and his navigator fared any better. Trying to take off in a cross-wind an hour after Hawker, their tiny scarlet and yellow biplane was caught by a sudden gust and slammed into the ground, fortunately without killing its occupants.

There was no longer any hope that a British pilot would be first across, although it was ten days before the American NC-4 flying boat left the Azores for Lisbon, and a further five days before she touched down in Plymouth Sound, a stone's throw from where the Pilgrim Fathers had set sail for the New World in the *Mayflower*, 299 years earlier.

Nevertheless, nobody had yet made a non-stop flight or claimed the £10,000 prize, and the next pilot to match his skill against the Atlantic was John Alcock. With his navigator, Lieutenant Arthur Whitten Brown, crammed beside him in the Vimy's open cockpit, he took off from Newfoundland at 1.45 p.m. (4.13 p.m. London time) on Saturday 14 June 1919, assured by the 'met' experts of fair skies all the way to Ireland. Yet it was not long before their troubles started. Within an hour of leaving Newfoundland, Brown tried to tap out a wireless report of their progress, only to discover that the small propeller that drove the electric dynamo for the radio had disappeared.

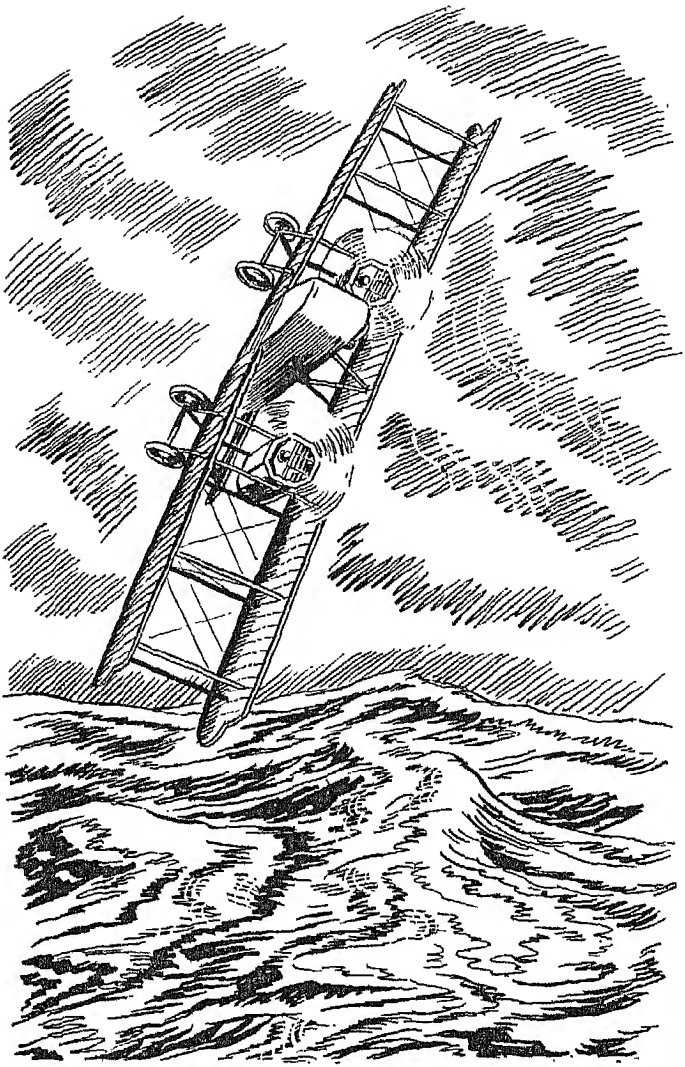
After what seemed an age, they climbed above the fog, only to find themselves in a kind of tunnel, with an unbroken layer of cloud above and fog below. Alcock knew they would have to see the sun just once before nightfall, to check their position. He eased back the control column a little more and the overloaded Vimy continued its slow climb into the dark, bumpy, eerie world of cloud that drifted past its fabric-covered wings and fuselage.

Without warning, there was a sudden clatter from the starboard engine, and both men watched horrified while a section of the exhaust pipe gradually broke away, slamming repeatedly against the side of the engine until it became white-hot and melted. From that moment, they could no longer talk to each other, because the exhaust gases poured from the engine in a fiery, unsilenced stream that almost deafened them.

Realizing that it might have been far worse, they decided to have a quick meal of sandwiches and a drink, in case they had no time later. Not until they had been in the air for more than four hours did the Vimy break above the clammy grey clouds at a height of 6,000 feet. Even then the sun shone on them for only ten minutes; but it was long enough for Brown to prove that they were within a few miles of their estimated position.

Then they were back in the clouds, which towered around and above them on every side, making the Vimy seem like a tiny fly, alone and trapped inside a vast jam-jar of swirling mist. On and on until, just after midnight, they again broke cloud into the magic fairy-land of the night sky, black with its myriad pinpoints of stars and a moon that seemed friendly and familiar. They were beginning to feel tired and cold, because their electrically-heated flying suits had failed long ago: and yet they were confident, with nearly half the journey behind them. It seemed merely a matter of droning on and staying awake, and they dropped steadily to 4,000 feet to ease the strain on the engines which had been running hard for over eight hours.

Soon after three o'clock on Sunday morning, as dawn was beginning to light the sky, the Vimy flew out of cloud into a clear patch of air. A few minutes later, the flight nearly ended in disaster. Alcock and Brown just had time to see the storm cloud that blocked their path like a black mountain before the Vimy plunged into it.



All sense of balance and direction had gone and when they broke cloud the Vimy was almost on its back.

Words cannot convey the horror of what followed as the aeroplane was tossed around like a leaf by raging torrents of wind that screamed past its straining wings. All around them, lightning tore gaps in the thick vapour which hid from sight the wing tips and even the nose of their aircraft. Hail slashed into the cockpit, as they were slammed from side to side by the frenzy of the storm-cloud which threatened at any second to tear off the Vimy's tail.

Slowed by the wind, the bomber suddenly shuddered, as if clawing in vain to stay in the air, then stalled, toppled, and began spinning down towards the sea with its engines racing flat out. Almost in a daze, Alcock watched the altimeter needle swinging from 4,000 feet to 3,000 . . . 2,000 . . . 1,000. He managed to throttle back the engines; but the Vimy continued its headlong plunge into the darkness below. Without any hint of panic or fear, Alcock continued to struggle with the controls. The altimeter showed 700 feet . . . 500 . . . 400. . . . He felt the aircraft beginning to respond; but all sense of balance and direction had gone and when they broke cloud 60 feet over the stormy sea, the Vimy was almost on its back, with the water above their heads. Quick as a flash, Alcock righted it. The spray from the waves pattered against the bottom of the aircraft's wings, and it was some minutes before he realized that they were flying west, back to Newfoundland. Then, laughing as much with relief as amusement, he banked round and set course once more for Ireland.

Their lives had been saved by the great sturdiness of the Vimy, the reliability of its engines, and Alcock's superb flying; but the dangers were not yet over. Back at 6,500 feet, the sun was hidden by menacing banks of cloud that poured drenching rain onto them, and they could make little more than 100 m.p.h. against the head wind. Then it began to snow. Alcock climbed to nearly 9,000 feet to try to get above the clouds, without success, and

soon the engines began to lose their steady beat, as their air intakes became blocked with snow and ice.

This time it was Brown who saved the day. Although half-crippled by a war-wound, he clambered out of the cockpit and onto the ice-covered wing. With the freezing slipstream from the propeller tearing at his body, he hacked away the ice from first one engine and then the other, with a knife. Almost exhausted, he fell back into the cockpit. He had to repeat the process again a short time later . . . and then again, and again, and a fifth time, without a parachute and with 9,000 feet of stormy sky beneath him as he gripped the icy wing struts.

Still they climbed, to 11,000 feet, where a faint watery sun was but a poor exchange for the tiredness they felt after fifteen hours in the air, and for ailerons which were iced-up and useless.

It would have been cruel to fail when Ireland was so near. Yet there was another ordeal to come. Its air intake and radiator once more blocked, the starboard engine began to misfire in a series of loud explosions and the temperature of its cooling water rose rapidly. Their only chance was to lose height slowly, in the hope that the ice would thaw in the warmer air beneath them. So Alcock throttled back both engines, and they began a gradual descent. Remembering their earlier experience, fear began to grip them as they got lower and lower without breaking clear of the dense clouds. Not until they were down to 500 feet above the sea did they emerge into clear air: but then, as if to share their joy, both engines broke into a healthy roar when Alcock opened the throttles and, with a slight change of course, they began the last stage of their long flight, skimming 200 feet above the wave tops.

Two tiny specks appeared on the horizon, looking at first like ships. Instead, they proved to be islands and, a few glorious minutes later, the Vimy was circling over the still sleeping town of Clifden in Ireland. The Atlantic

had been conquered non-stop for the first time by British airmen in a British aircraft with British engines. What did it matter that the green 'meadow' they chose to land on proved to be a peat bog, so that fate could have one last smack at them by ending their 1,880-mile flight in a crash-landing.

No men in history had deserved more the prize of £10,000 and the tremendous welcome that awaited them in London—or the Royal honour that made them Sir John Alcock and Sir Arthur Whitten Brown. It is no less fitting that, today, a statue to their memory should stand near the runways of London Airport, looking at the huge airliners that fly as a mere day-to-day routine over the skyway they pioneered.

CHAPTER SIX

THE MAIL GOES THROUGH

FEW people today remember the name of Jack Knight, the mail-pilot. Yet, on 22 February 1921 he was as great a hero to the small boys of America as any Davy Crockett. Not that they were particularly air-minded, because flying had struck a bad patch in the country where it had started eighteen years earlier. Those years had produced few designers of the calibre of the Wrights or Glenn Curtiss, and when U.S. airmen came to Europe to fight in the 1914-18 War they had to fly French and British warplanes.

As a result, when the war ended, there was no rush to start airline services in the United States, as there was in Europe, because there were no suitable aircraft to operate them. If an ex-military pilot wanted to go on flying, his best bet was to buy cheaply one of the Curtiss 'Jenny' trainers that the Army Air Service no longer needed, and barnstorm across the country giving flying displays and joyrides to people who had never before been close to an aeroplane. Those who could not afford to do this could become wing-walkers, clambering from one aeroplane to another in flight or swinging on a trapeze slung from the undercarriage of someone else's aircraft. Others became stunt pilots in Hollywood, which was as good a way as any of making a lot of money quickly, provided you had no plans for the future.

The nearest thing to an airline was the air mail service run by Otto Praeger, the U.S. Assistant Postmaster-General, and even this was almost as dangerous as flying fighter planes during the real war in France or the celluloid 'wars' in Hollywood.

It had been started with aircraft and pilots borrowed from the Army, in an attempt to speed up mail delivery over difficult routes. This was in the best tradition of the Post Office, which had pioneered almost every form of surface transport from the pony express to motor vans. So was the Post Office's decision in mid-1918 to become independent of the armed forces by buying seventeen aeroplanes of its own.

The only available aircraft, apart from 'Jennies', which were too low-powered, were ex-Army de Havilland D.H.9 biplane bombers, designed in Britain, but built in America. With their open cockpits, light wood and fabric construction, and 400 h.p. Liberty engines, they were first-class in the jobs for which they were designed, but these did not include carrying air mail over mountains in mid-winter.

They started almost too well, with such a fine performance on the experimental Washington-Philadelphia-New York route that Praeger was already thinking in terms of a 3,000-mile coast-to-coast air mail service across the continent before the end of 1918. He was given permission to open the first part of this route, between New York and Chicago, over the dangerous Allegheny Mountains, provided he could guarantee that his pilots would uphold the honour of the Post Office by flying in all weathers. Although there were no emergency landing fields and no navigation aids, he gave his promise, and his pilots did their best not to let him down. But the weather on the day chosen for the first flights, in November 1918, was about as bad as it could possibly be, and the pilots who took off in their D.H.9 'flying bricks' from each end of the route were forced down by storms almost as soon as they left the ground.

Two months later they tried again, only to fail for the same reason. Determined not to be beaten, Praeger built emergency landing fields and decided to restrict the service for the time being to the Chicago-Cleveland

sector. This time, his pilots got through, and when the summer brought better weather, they showed at last that they could fly the mail over the whole route, including the 'hell stretch' from New York to Cleveland over the Alleghenies.

That was only a start, and within two years Praeger had his transcontinental service running all the way to San Francisco. By flying the mail by day and loading it on trains at night, the coast-to-coast delivery time was cut from 90 to 72 hours—but not without cost, for thirty of the forty pilots who pioneered the service died whilst flying the mail.

They were a mixed bunch; but most came under the heading of pilots who 'flew by the seat of their pants'. With hardly any instruments and no radio to guide them, they relied on instinct to keep their aircraft straight and level and on course in bad weather, plus a few bright ideas like Dean Hill's cigar.

Hill was one of the pilots who flew regularly on the 'hell stretch' and, like all the others, he navigated by following railway lines, roads, and similar landmarks on the ground when the weather was good. When it was bad, which was more often than not, with the Alleghenies hidden under a blanket of grey fog or cloud, he made a habit of lighting a big cigar as soon as he took off from the emergency field at Bellefonte. After that he cruised along quite happily above the clouds until the cigar had burned down to a length of about two inches, by which time he reckoned he was over his destination. He usually was, and claimed that his cigar was the first satisfactory blind flying instrument.

Sometimes the weather became too bad even for men like Hill. There was, for example, the day when Frank Yaeger had to land because of dense fog while still fifty miles short of his destination at North Platte, Nebraska. Tired of sitting around on the ground, he taxied across the prairie until he came to a fence, opened

up the motor just enough to hop over it, and then resumed his taxi-ing until he met the next fence. He covered the whole of the last fifty miles in this way, and handed over his mail bags in North Platte in the kind of weather when even the birds were walking.

Another pilot finished his journey after a forced landing by leading a string of donkeys into the city of Reno, each carrying a sack of mail on its back.

Despite the courage, initiative, and achievements of these pilots, it seemed as if the air mail service would be closed in the spring of 1921. The Government had to find ways of saving money, and it seemed hardly worthwhile spending dollars just so that a bunch of enthusiastic pilots in tired old aeroplanes could cut a mere 18 hours off the time taken for letters to travel across the continent.

Praeger was not the sort of man to give in without a fight, and neither were his pilots. They decided that the only way to keep the air mail service in existence was by proving it could save a great deal more time by flying at night as well as by day. So they planned to run two services in each direction between San Francisco and New York, starting on 21 February, and flying the mail all the way in a relay of aircraft.

Arrangements were made to have bonfires lit along the route during the night; but it was still an almost hopeless gamble, especially when the early hours of the 21st brought virtually unflyable weather. The two westbound services were cancelled and one of the aircraft from San Francisco crashed. It seemed as if the whole gallant operation must fail; and yet the one remaining service kept going, from San Francisco, over the Sierra Nevada mountains to Reno, and on to Salt Lake City, Cheyenne, and North Platte.

There it was held up for two hours, while mechanics mended the tail skid of Jack Knight's ancient D.H.9, and it was not until 10.45 in the evening that he was able to start on his leg of the long flight to Omaha. For nearly

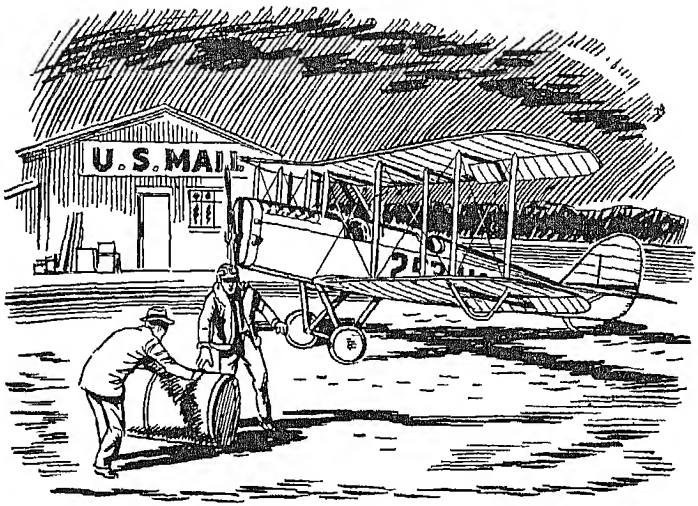
2½ hours he droned on through the night, grateful for the bonfires that blazed at intervals along the dark route and wishing that a little of their warmth could reach out into his freezing open cockpit. The fires that marked the end of his sector at Omaha airport were one of the most welcome sights of his life, bringing a vision of hot food, an even hotter drink, and bed.

Within minutes, he dropped from the cockpit that looked as if it was made from old orange-boxes, with wires and cables running along the outside, and prepared to hand over his mail to the next pilot. But there was no 'next', because the man who was to have flown the Omaha-Chicago sector had been unable to get through.

It seemed as if all the effort had been in vain, until Knight suddenly announced that he intended to carry on to Chicago. In vain, the airport manager pointed out that he had never flown over the route even in daylight. Knight waited just long enough to drink a hot coffee and to get a vague idea of the sort of country he would be flying over with the aid of an ordinary road map. Then, with the last few flakes of a snowstorm whipping like confetti past his helmeted head, he was climbing again into the night that was no longer lit by bonfires, because the word had been passed along that the flight was abandoned.

Soon he must have begun to wish that it was. Strong side-winds did their best to blow the aircraft off course as it bumped and swayed in what he hoped was the right direction for Des Moines. From time to time he glanced at the road map with the light of a small torch, and then flew blindly for several minutes while his eyes became used to the dark again, before craning his head over the side into the biting slipstream to try to pick out landmarks on the snow-covered ground.

At last, when his main petrol tank was almost dry, he spotted Des Moines; but there was far too much snow to chance landing. So he switched over to his emergency



They filled the petrol tank and soon the dog-tired pilot was off once more.

tank and hoped it would keep the engine ticking over long enough to get him to the emergency field at Iowa City. It did, but when he got there the whole place was in darkness. Just as he was giving up hope of a safe landing, he saw the burst of a red flare and came down as near to it as he could. It had been lit by the night watchman, who was alone on the airfield.

Together, they filled the D.H.'s petrol tank from a large drum and soon the dog-tired pilot was off once more, through the fog, up and over the clouds towards the dawn and the end of his long journey. Then everything seemed to happen at once. The fog cleared to reveal the landing field at Chicago and, at that precise moment, the Liberty engine began mis-firing for the first time since the aircraft left North Platte. It could have fallen out altogether for all Knight cared, as he glided down,

bumped to a standstill, and found himself surrounded by a crowd of cheering, excited men and women. Most of them were still in evening dress, having dashed straight from late-night clubs to welcome the pilot whom the newspapers were already proclaiming a hero.

It was the last thing that Jack Knight had expected for merely doing what he considered his duty. And there were many more surprised people, especially in the Government, when the sacks of mail that he had carried nearly 750 miles were flown into New York by the last of the nine pilots in the relay, only 33½ hours after they left San Francisco, cutting the delivery time to less than half.

More important than all the newspaper headlines was the fact that the Government decided not merely to keep the air mail service going, but to spend over half a million dollars on providing proper beacons to light the airways. Without them, the later development of America's vast network of passenger airlines would have been slower and far more hazardous. At least one of the airline pilots had good reason to know this, because by the time Captain Jack Knight retired as one of United Air Lines' senior pilots in 1937, he had some two million miles of flying recorded in his log book.

CHAPTER SEVEN

THE SPIRIT OF ST LOUIS

THEY called Charles Lindbergh the 'Flying Fool' when he planned to cross the North Atlantic alone in a small single-engined aeroplane without night flying equipment, radio, parachute, or even a windscreen to see where he was going. A mere handful of men had followed successfully the trail blazed by Alcock and Brown more than seven years earlier. First had been Major Scott of the Royal Air Force and his crew of 31, who had completed both the first west-bound crossing and the first round trip, in the airship R-34, within a month of the Vimy's non-stop flight. Two U.S. Army crews had also flown from east to west in 1924, on the last stages of a round-the-world flight in Douglas World Cruiser biplanes; but they had done the trip in easy stages, via Iceland and Greenland. Apart from another airship, the German ZR-3, which made the westbound flight in 1924, that was the lot.

Nobody but Alcock and Brown had made a non-stop crossing in an aeroplane. Yet here was a young American who planned to fly not on the shortest hop from Newfoundland to Ireland, but all the way from New York to Paris, a non-stop distance of 3,600 miles. It meant that by the time he reached the point from which the British crew had started, he would already have spent eleven hours in the air by himself in a tiny cramped cockpit; and that when he reached their landfall he would still have another six hours to fly.

Aircraft had, admittedly, improved tremendously since 1919. They were stronger, their engines were more reliable, and bad weather was less of a hazard. But it

still seemed an impossibility for one man to find his way over such a route, flying, navigating, trying to stay awake through two days and a night, especially when he had no great experience of navigation and had never before flown over a stretch of water for longer than twenty minutes.

They failed to realize that Charles Lindbergh was no ordinary pilot, plunging blindly into some crazy scheme for the sake of fame or fortune. There seemed a good chance that both would come to him if he were successful, because a gentleman named Raymond Orteig had offered $25,000 to the first airman who linked New York and France non-stop in a heavier-than-air landplane or seaplane. But when Lindbergh took off at the start of his long flight on 20 May 1927, he did not qualify for this prize, so the incentive must have been more than just money or headline-seeking.

He had already had more than his share of excitement since he learned to fly, in Nebraska in 1922, when he was 20 years old. Half-way through his lessons, the school had sold its only trainer to a pilot named Erold Bahl, who planned to take it barnstorming. With insufficient cash to hire another aircraft, Lindbergh pleaded to go along with Bahl, who agreed, provided he paid his own expenses. It was about the best thing that could have happened, because the older man was a fine pilot, who flew in weather that grounded other barnstormers, and yet he never took silly chances. Under his tuition, Lindbergh learned that the stunts that looked so dangerous to people on the ground were quite safe for any airman who knew the limitations of his aeroplane and his own skill.

This went for wing-walking and parachute-jumping as well as aerobatics; and soon he decided to learn both jobs to add to the attractions of the barnstorming show and his own income. He discovered that, when wing-walkers appeared to hang by their teeth from a trapeze,

they were supported by a steel cable attached to a harness under their flying jacket. Even standing on the top wing while a pilot looped was not dangerous when the wing-walker was firmly anchored by four strong cables, and parachuting was safe enough provided he took care when packing the 'chute and choosing the pilot from whose 'plane he jumped.

The experience Lindbergh gained served him well later when, as a pilot in the Army Air Service, he collided with another aircraft in his formation and saved his life by taking to his parachute. Twice more he had to jump to safety when, as a flying postman of the U.S. Air Mail Service, he ran into trouble at night, without any chance of landing his D.H.9 in one piece. But, like so many of the other pilots, he resented having to fly worn-out, underpowered aircraft, just because no money could be found for anything better.

U.S. aircraft firms had first-class designs on the drawing board and even in the air. They were crying out for orders to keep them in business and, as he hauled his loads of mail on the St Louis-Chicago run, Lindbergh began to realize that if people with the money could be shown something of the capabilities of modern aircraft, the result might be not only better machines for the Air Mail Service but a new lease of life for the airlines, which were trailing far behind those in Europe.

What was needed was a spectacular flight that would prove the safety, reliability, and performance of the new aeroplanes—something like a flight from New York to Paris—and why shouldn't he be the one to do it? He talked it over with friends, who put him in touch with a number of St Louis businessmen. They must have been impressed by the slim, shy young man who spoke of flying further than anyone had ever flown before, over one of the world's worst airways, for they agreed to find most of the $15,000 he believed would be needed for the job, with

only a slight chance of seeing their money again if he won the Orteig prize.

Lindbergh knew the aircraft he wanted, a Wright-Bellanca with one of the powerful new Whirlwind engines. His friends were horrified at the thought of all that water and only one engine. He argued that if one motor failed on a heavily-loaded three-engined machine it would be no better off. 'Take a navigator', they pleaded. He recalled the words of his father many years earlier, that 'One boy's a boy. Two boys are half a boy. Three boys are no boy at all'. He told them again about Captain Fonck who had crashed when taking off in the big three-motor Sikorsky for an attempt at the flight he now wanted to make. There had been constant bickering before Fonck had started. Crew members had been changed. Then part of the undercarriage had collapsed as the machine lumbered down the runway. Even three engines could not lift it into the air and two men had died.

'If I fly by myself, there'll be no arguing. Besides, the weight saved can be used to carry more petrol. Then, even if I'm miles off course when I reach the other side, I'll have fuel to spare, and be able to fly around until I find my bearings.'

They asked him, at least, to inquire the price of a three-engined Fokker monoplane. He did. It was $90,000, and the company was not interested in building a single-engined aircraft for anyone who was foolish enough to think he could cross the Atlantic in it. Neither was the Travel Air Company. Bellanca said that their aircraft was quite capable of making the flight—in fact, it was the only one that could—and they would let him buy it for $15,000, provided their own pilot flew it!

It was at this moment that the Ryan company of San Diego offered to design and build for him a special version of their Model M monoplane *within two months* for around $6,000. Hardly able to believe it, Lindbergh decided to fly to San Diego to talk to them. He knew

their Model M, a little open-cockpit, high-wing monoplane used on Pacific Air Transport's mail run down the California coast. Not really the kind of thing for an Atlantic flight. Still, it seemed like that or nothing.

He liked the look of the people at Ryan. There were not many of them and it took only a few minutes to inspect their factory; but they were enthusiasts, craftsmen, honest folk who would not let him down if sheer hard work and fine wood and metal structures were capable of what he demanded from them. Together, they thrashed out the necessary changes to the Model M airframe, and it soon became clear that the result would contain very few of the existing parts! Nonetheless, Ryan stuck to their promise of an airframe for $6,000, which came to a total of $10,580 (then about £2,200) when fitted with a 220 h.p Wright Whirlwind J-5C engine and equipment.

They were a little shaken by some of the ideas put forward by their customer. To fly alone was bad enough; but he wanted to shut himself inside the small fabric-covered fuselage with an enormous fuel tank in front of him, right up to the level of the wing, with no windscreen to see through. Yet his arguments were sound. Nobody ever used a windscreen for take-off because the nose of the aeroplane blocked all forward view, and he was not likely to meet any other aeroplanes over the route he planned to follow, so could see all he needed out of the side windows. A small retractable periscope could be fitted to give some sort of view past the nose; and, anyway, if he crashed, it was much better not to be sandwiched between the engine and fuel. What was more, the improved streamlining would be worth an extra hundred miles of range.

The wings had to be made longer to carry the extra load, and the undercarriage heavier. One snag was to design and test a new and bigger tail in two months. 'Would it be dangerous to fly with a Model M tail?'

asked Lindbergh. 'Not for an experienced pilot.' So the small tail stayed on, and a few more miles were added to the range. The result promised—and proved—to be rather unstable. He said this was just as well. It meant he would have to concentrate on flying straight and level every minute of the flight, which would help to keep him awake. So would the uncomfortable wicker seat.

He knew, even then, that sleep would be his greatest enemy, and as he waited to take off, at the end of the long runway on Roosevelt Field, New York, less than three months later, he already felt a little tired.

He would have liked to delay another week. For one thing, he could not hope now to win the Orteig prize to repay his friends. The rules said that two months must elapse between acceptance of an entry and take-off. His entry had been accepted on 27th March. It was now just after 7.30 on the morning of 20th May. But, in hangars not far away, were Chamberlin's Bellanca and Byrd's tri-motor Fokker, both almost ready to start, and he could not take a chance on being beaten after all the work and excitement of the last few months.

Only the previous morning, his proposed route had been hidden by fogs and he had not bothered to get a lot of rest. When he had got to bed at midnight, he had lain awake for the 2½ hours when he should have slept. Now it was too late, and the far more immediate problem was whether the little monoplane, now named the *Spirit of St Louis* in honour of the home-town of his backers, would be able to lift itself off the ground. Could 220 h.p. lift 5,250 lb.? If not, what a bonfire 2,750 lb. of petrol would make.

Soon, the chocks were away. Friends pushed on the wing-struts to give the aircraft a start. It felt as heavy as an overloaded lorry. He watched more and more of the runway disappearing past the side-windows, which were open to the air so that the cabin would not get stuffy and it would be easier to stay awake.

Just over half-way down the mile-long strip, the wheels unstuck; but the heavy load immediately crushed them back on the runway. Off again. Another bounce that shook every rivet and strut. At last, the smoothness of flight, with the ground falling away so very slowly beneath. He hardly dared to bank, because the slightest movement seemed to make the aircraft want to topple from the air.

It was 7.54 a.m. local time, and ahead extended 3,600 miles of the unknown, with only a meteorologist's promise of good weather.

The first two hours passed quickly and there, ahead, was the Atlantic. Now was the time to fetch out the map on which he had spent so many careful hours. He had no radio, because its weight would have cost too much in precious fuel, nor a sextant, because he could not use it and fly the aeroplane too. His navigation would have to be by dead reckoning, taking count of the direction and strength of the wind and the readings of his instruments to follow the course he had marked out as a succession of 100-mile stages across the long strip of map. Success depended on the accuracy of his guesses and he decided to test his chances by seeing how many degrees he strayed off course over this first 250-mile stretch of ocean between Massachusetts and the coast of Nova Scotia.

He felt tired, but he knew it would pass after a few hours, and the bright sunlight that streamed through the window above his head held promise of fair skies until then. Fifty feet below, the waves seemed calm and friendly. Would they look the same after another twenty hours?

Just after mid-day, Nova Scotia appeared ahead, and soon he was over St Mary Bay, a mere two degrees off his course. He had reckoned that an error of five degrees would be good. If he could fly as accurately the rest of the way, he would be within fifty miles of his course when he reached the coast of Ireland, which would be fine.

But there was the night, and the weather, and tiredness all teamed up in the fight against him.

Six hours from New York, he flew into a storm, which wrenched at the heavily-loaded wings until it seemed they must snap under the strain. He longed to feel the familiar bulk of a parachute: yet during most of his flight it would have offered no safety and had been sacrificed for twenty minutes' fuel. Within an hour, the *Spirit of St Louis* was already flying out of the bumpy squalls, and he knew the decision had been right.

Newfoundland lay 300 miles ahead and he suddenly felt tempted to leave his carefully-plotted course and fly over St John's, from where Alcock and Brown had set out on their crossing before he had learned to fly. It seemed sensible, because someone would be bound to see him and tell the folks at home that all was well. And if he came down in the sea, at least they would have a position and time on which to base their search. Heartened by the accuracy of his earlier navigation, he swung the aircraft on to its new course and, later in the day, the *New York Times* carried a great banner headline proclaiming: LINDBERGH SPEEDS ACROSS NORTH ATLANTIC, KEEPING TO SCHEDULE OF 100 MILES AN HOUR; SIGHTED PASSING ST JOHN'S, N.F., AT 7.15 P.M. The 'flying fool' was already changing into a hero. He alone realized fully that the 1,100 miles he had flown were easy compared with what lay ahead; and he was already having difficulty in staying awake.

Alone with his thoughts, he began dreaming and then waking with a start to find the aircraft creeping off course. Shutting his eyes for what seemed a second, he opened them to find that the hand on his clock had moved a minute, that the left wing had dropped, and the compass swung 10 degrees. The *Spirit of St Louis* needed flying every second. He stamped his feet, held his hands out of the open windows into the icy slipstream, studied carefully the great icebergs floating past below, realizing that

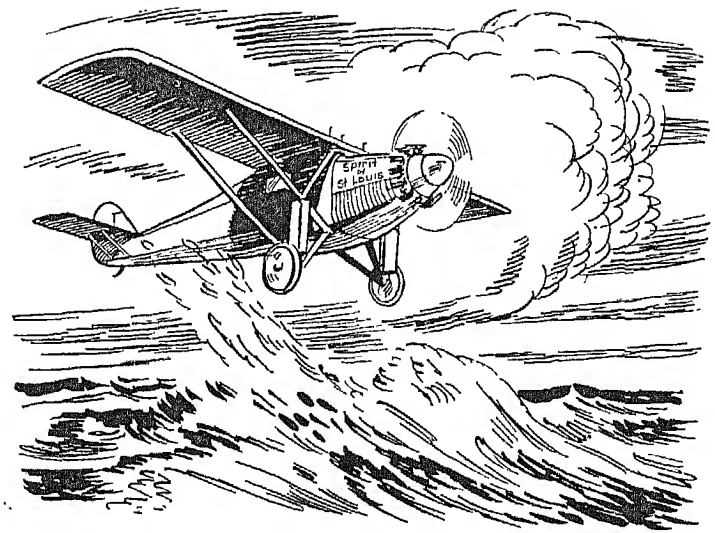
every tiny change of scenery gave him something different to think about, to help him to stay awake.

He began to climb steadily to get above the heavy haze that came with nightfall. Then on and on, hour after hour. He spent ten frightening minutes escaping from a storm cloud that began to coat the wings with ice. Then his compasses began to swing madly in an electric storm and, to the almost hopeless fight to keep awake was added the fear that he was wandering off course. Every time he checked his map, the aircraft swung, and he wondered what had been the effect of weaving through the storm clouds. Had he been carried off course by the wind? He was halfway; but for all he could see, for all he knew, he might be anywhere in time and space.

At last came the first light of dawn. Now, at least, he could get some idea of the wind direction. Slowly, the aircraft lost height, down and down until it was skimming only 50 feet above great tossing waves. The whole ocean was white, and he knew that the sort of gale that could whip the Atlantic to such a frenzy must be blowing at 50 or 60 m.p.h. What was more, from its direction, it must have been adding many miles an hour to his speed and blowing him slightly off course all through the night.

Just in time, he saw the approaching fog and, as the *Spirit of St Louis* nosed into it, the stick was already back, and the needle of the altimeter swinging up. Later, out of the fog once more, he descended until his wheels were clipping five feet over the wave tops. By now, he was desperately tired. The fog banks began to look like islands and coastlines, tempting him off course. Yet he knew real land was still hundreds of miles ahead. When it appeared, would it be the green fields of Ireland, the rocky coast of Cornwall, or even the fjords of Norway, many more hours away?

He increased speed in the hope that he would reach



He descended until his wheels were clipping five feet over the wave tops. He was desperately tired.

land before nightfall, to have a chance of working out his position. His eyes still played tricks, seeming to see a fleet of small boats ahead. But this time they *were* boats. He circled them happily, shouting to ask where he was, above the roar of his engine. No reply. Yet, soon, came one of the most wonderful moments of his whole life, for when the coastline came in view he was over Valentia and Dingle Bay in S.W. Ireland, just three miles from where he had hoped to make landfall; and he was two hours ahead of schedule. It seemed hardly possible that his navigation could have been so accurate, when even a 50-mile error would have been considered good. In the excitement, he failed to notice that the aircraft was swinging round, and when he looked up Ireland had

disappeared. In fact, he was heading back towards America!

That was easy to put right and it seemed impossible that anything could now go wrong, because the weather was good, the aircraft was flying better than ever, and there was sufficient fuel still in the tanks to reach Rome. Nor did he feel tired any longer. Only when he tried to eat his first food, a tasteless sandwich, did he realize how dull his senses had become.

On and on, over St George's Channel, Cornwall, the English Channel, unaware that excited wireless messages were flashing news of his progress to every corner of the globe. Half of Paris began pouring out to Le Bourget Airport, which was lit by floodlights and the headlamps of hundreds of motor cars. When Lindbergh arrived over it just before ten o'clock on the evening of 21st May, he could not recognize it as an airport. He looked for another without success, decided it must be Le Bourget, and began one of the most difficult landings of his career, with only the periscope and side windows to see through.

A gentle bump as the *Spirit of St Louis* touched the ground in a perfect three-point landing, and the 33½-hour flight was ended. The 100,000 people that stampeded towards him, crowding so close that the wooden fairing strips on the fuselage began to crack one after the other, gave only a hint of what lay ahead in the next month. Raymond Orteig had no hesitation in sending his cheque for $25,000, to go with the medals, honours, and trophies that, today, fill a museum at St Louis.

CHAPTER EIGHT

OVER THE POLE

It's fun to turn over the pages of an atlas and to dream of visiting one day the far-off countries whose shapes have become familiar through its brightly-coloured maps. In our imagination, we cross the wide blue oceans, see the snow-caps of the highest, darkest mountains and feel the heat of the yellow deserts. As we do so, we can be fairly certain that, during the next few hours, some lucky air traveller will look down from the comfortable cabin of a fast-flying airliner at the country we see only as a printed picture on a scrap of paper: for there are few places on earth that do not hear the roar of aero-engines in this age of flight.

Yet, at the end of many atlases, there is one page that shows how much we still have to learn about the world we live in. Instead of being painted in bright reds, greens, and yellows, it is often plain black, with a few white-printed names around the edge and almost nothing else but the words 'Amundsen 14:12:11' and 'Scott 18:1:12' at the exact centre. To these should be added the names of 'Byrd and Balchen' and the date '29:11:29': for this is the barren waste of the Antarctic, and these were the first men to travel by air to its very heart.

It is black and featureless on the map because we know so little about it. Even when British, American, New-Zealand, and Russian explorers have added all the new knowledge gained from the 1957-58 Geophysical Year expeditions, it may still be a long time before the Antarctic's five million square miles can become of any value to man. Nor is black such an ill-chosen colour to represent a continent that is itself the most brilliant

dazzling white, for black is a forbidding colour, and the Antarctic is the most cruel and forbidding place on earth.

Lieut. Commander Richard E. Byrd of the U.S. Navy and his pilot, Bernt Balchen, had some idea of the problems they faced when they set up their base camp at a spot they named Little America, 800 miles from the South Pole. Three years earlier, Byrd had been the first person to fly over the North Pole, in a tri-motor Fokker monoplane, piloted by Floyd Bennett and fitted with a ski undercarriage designed by Balchen. Now Bennett was dead, but the Ford monoplane in which his friends hoped to reach the South Pole had his name painted proudly on its side. Nor was it the first time that Byrd and Balchen had planned a great flight together; for they had crossed the North Atlantic from New York to Paris in the Fokker *America* six weeks after Lindbergh, only to find the French capital shrouded in fog, so that they were forced to fly back to the coast and ditch in the sea near Cherbourg.

This time there would be little hope of surviving a forced landing; but the Ford and its Wright engines were as reliable as any in the world and the whole expedition was planned by Byrd with such thoroughness that only the unknown dangers of the Antarctic itself remained to be feared.

The base at Little America buzzed with as much activity as a small town, because no fewer than four boats had been needed to carry in the expedition's personnel and equipment, which included single-engined Fokker Universal and Fairchild monoplanes as well as the *Floyd Bennett*. Balchen's aviation team alone included three more pilots, three mechanics, and an air photographer named Captain Ashley McKinley, who had been a kite-balloonist in the 1914-18 War.

No sooner was the Fairchild uncrated and assembled, in January 1929, than Byrd became impatient to begin his exploring. It had a shorter range than the Ford;

but even a few miles might bring some great new discovery. Into the cabin went the emergency equipment that had to be carried on every flight—hand sledges, tent, primus stove, radio, special clothing, sleeping bags, and food for a week. Then, with Balchen at the controls, they were off, along the coast of King Edward VII Land, past the mountain that Scott had named Nunatak and the long 1,500-foot high Alexandra range, on into territory that no man had ever before seen.

A snowstorm forced them to change course to the south, almost directly towards the Pole. Suddenly, Balchen saw far ahead a great dark mass rising from the flat bleak whiteness. As he shouted for Byrd, the mass began to take shape as a mountain, its summit bared of snow by icy gales. Then another peak appeared, and another, until Byrd had counted fourteen, with others beyond curving in a great crescent as far as the eye could see. Unfortunately, the fuel gauge said it was time to turn for home; but the Antarctic had given them a hint of the excitement that lay ahead, and Byrd decided to name the new mountains after John D. Rockefeller, Jr.

For the next few days there was no chance to fly, because the *Eleanor Bolling* had arrived, carrying the Ford and Fokker aircraft. No time could be wasted in unloading them, because the great ice shelf against which the vessel was moored was beginning to break up. No sooner had the Ford's centre-wings been unloaded than the ice on which they were resting broke off and started to drift away. Quick as a flash, hooked lines were fastened on to the floe to drag it back, and the wing section was hauled onto more solid land. The worst moment of all came later, when a great towering mass of cliff fell away with a crash like the firing of a cannon shell, right onto the *Bolling*. The little ship rolled on to her side: yet, by a miracle, was not sunk. Fortunately too, by that time, the aircraft had been unloaded and were already being assembled at Little America.

Anxious to get down to serious exploration before the Antarctic winter set in, Byrd and Balchen made further flights in mid-February in the Fokker, which had been named *Virginia*, accompanied by two other pilots in the Fairchild, now known as the *Stars and Stripes*. Yet another great mountain was discovered, this time a lonely peak about 5,000 feet high, and what appeared to be a high plateau far to the east of the Rockefellers. Only one more flight was made that autumn, to a frozen lake near these mountains, so that Dr Lawrence Gould could collect some rock specimens. All went well on the first day; but on the second their little camp was hit by a freezing gale. They worked frantically, piling snow over the skis of the *Virginia* to hold her down, and building a wall around her with blocks of snow to ward off the worst of the storm. It became so bad that they could lean against the wind as if it were a wall. Ropes were tied to the aircraft's wingtips to lash it down, but still the wind tore at it.

By the morning of the third day the gale had abated; but it snowed so heavily that flying was impossible. The only consolation was that Gould found traces of the rocks he had been looking for. But the pleasure was short-lived, for the following morning brought the first signs of a blizzard terrible beyond their wildest dreams. All day they worked to strengthen the wall around their aircraft in a gale that rose to 100 m.p.h. by noon. The radio with which they had been in contact with Little America failed, and the future seemed grim when Gould looked outside the tent and saw that the *Virginia* had disappeared. When Balchen went to inspect it next morning, he was blown off his feet in a sprawling heap against the 'plane, which was damaged beyond repair. It took him two hours to crawl the half mile back to the tent, in a wind that blew at 160 m.p.h.

Not until the eleventh day was the Fairchild able to fly in to rescue them. After that its engine and wings

were removed, like those of the Ford and, when the sun set for the last time in mid-April, the two aircraft were greased, wrapped, and stored in hangars made from blocks of solid snow. The men settled for the long winter in rooms hollowed out of the snow, yet strangely comfortable and warm, and in prefabricated huts with walls and ceilings of insulated board.

No time was wasted. As the days passed, plans for the summer exploration were made, discussed, and checked in the most minute detail. It became more and more certain that the *Floyd Bennett* would be unable to make the 1,600-mile round trip to the Pole and back in one non-stop flight. The purpose of the operation was to photograph every inch of the ground between Little America and the Pole, and the camera alone weighed a hundredweight. When they added on the weight of a sledge, emergency supplies, four men, and petrol for 1,600 miles, the result was far too heavy for the Ford to carry up to the central Antarctic plateau, by passing through the 14,000-foot Queen Maud Range of mountains, which cut it off from the west.

Balchen suggested leaving behind the emergency food supplies; because if they were forced down onto the plateau there was little chance of getting out, no matter how much food they had; whereas an extra few gallons of petrol might save all their lives if fuel ran low during the flight. Byrd insisted that the food must be carried; so the only solution was to refuel half-way on the return journey.

Not until 18 November was all ready for the Ford to fly its load of fuel to the 'filling station', 440 miles away, by Mount Nansen in the Queen Maud Range. By then the ground support parties had already laid caches of food and supplies at fifty-mile intervals for Dr Gould's main geological party, which had set out to search for minerals, fossils, and data on the rock structure in the Queen Maud region. The conditions they encountered

defy description. Great crevasses waited to swallow them if they trod on the thin roof of ice that looked as solid as the rest of the white plains. Razor-sharp hills and ridges, dense fogs, snow-storms, blizzards and howling gales that carried cruel stinging needles of ice like horizontal rain, swirling milky mists that distorted everything in sight, so that sky was indistinguishable from land—all these, and the constant cracks and rumblings of the moving, living ice, made up a world horrible beyond any nightmare.

By comparison, the work of the flying party seemed easy and comfortable, even when the mechanic's hands froze to the metal of the aircraft, so that the skin was pulled off. But the preparations for the Polar flight did not go always to plan. Instead of flying straight to Mount Nansen to dump the fuel, Byrd had ordered the pilot to do some exploring on the way. As a result, soon after they took off on the return trip to Little America, the *Floyd Bennett* ran out of petrol and had to make a hurried landing.

When they failed to return, Balchen guessed what had happened and set out to search for them in the Fairchild, with 100 gallons of petrol in cans in the cabin. He soon found them, the fuel was transferred to the *Floyd Bennett's* tanks, and Balchen returned to Little America. Still the Ford failed to show up. There was little he could do, because of a sudden mist that had fallen. But next afternoon he set out once more to discover the cause of the trouble, and found that Byrd and his crew had been unable to start the cold engines. This was soon put right and both aircraft returned to base.

Now all was ready for the big flight, and they had only to wait for the best possible weather for both photography and navigation in completely unknown territory. On 27 November, a radio message from Dr Gould reported ideal conditions 100 miles from the Queen Maud Range and, at 3.30 the following afternoon, Byrd,

When 1,000 feet above the Trap they saw the party on the ground and dropped a bag by paraclute.

Balchen, his senior pilot Harold June, and McKinley the photographer took off in the *Floyd Bennett* on a flight that promised to be far more hazardous than any of Byrd's earlier exploits.

Hour after hour they droned on, 1,000 feet above the Trap, where the tracks of the ground parties could sometimes be seen amid swirling mist and the terrible crevasses that gave it its name. Soon after eight o'clock, they saw Gould's little party on the ground, and dropped by parachute a bag containing cigarettes, messages from home, and other comforts.

By now, the great mountain barrier could be seen ahead. Balchen opened the throttles slightly and began the long climb needed to carry them past the jagged peaks to the central plateau. Even from a distance of several miles, the sun glinted on the glaciers, and the air began to get bumpy, so that he found it increasingly difficult to control the big, heavily-laden monoplane.

He could see clearly the two passes through the mountains, first the valley of the Axel Heiberg Glacier and then that of the Liv Glacier, through which he had to fly. The *Floyd Bennett* was climbing far too slowly, and when he opened the throttles still wider, it began to buck and sway with ever-increasing violence. Unperturbed, McKinley continued to concentrate on his photography. June was bent over the radio and Byrd lost in his navigation problems.

Caught in fierce down-currents of air from the mountains, the Ford stood no chance of climbing over the pass, which was now looming ahead. Nor was there any response from the ailerons. Only Balchen could see the danger, but when he shouted 'Drop 200 pounds weight', June made a quick dash for the valve that would pour away some of their precious fuel.

'No', screamed Balchen, 'dump food.' With disaster in the form of great razor-edged peaks looming ahead, Byrd knew it was no time to argue. Overboard went a

150-pound bag of supplies. A little of the control returned, but not enough to save them. 'More, more', shouted Balchen. Out went a 250-pound bag. The Ford began to climb slowly and a few seconds later it was skimming just above the surface of the glacier. Even now it seemed that they must crash, because there was still a slight rise to get over and the *Floyd Bennett* had reached its limit. With no possibility of turning in the narrow pass, Balchen flew towards the wall of the canyon. At once the aircraft was lifted by an up-current of air, and the last few feet of ice slipped away, mere inches below its skis.

They were through, and yet it was almost unbelievable, for there had seemed no chance of survival in that moment when the second sack of food was thrown out. Now, as far as they could see, a great empty plateau stretched away into the distance, 1,000 feet below them, 11,000 feet above sea level. To the left were the high peaks discovered by Amundsen; far off to the right a new range never before seen by any man; in front, though still far away, the Pole.

They saw that the plateau was far from flat. Its height varied by as much as 1,500 feet, with huge snow ridges and domes like white-painted African villages scattered over its surface. In the teeth of the mountain winds and in the cold thin air, they could fly no more than 90 m.p.h. and, when immense black clouds began forming on each side of their track it seemed that, even now, they might have to turn back, their task uncompleted. To be caught by a storm in such a region could have but one end, and there was no sense in tempting fate too far.

Byrd rechecked his calculations. Perhaps there was just time to go on, circle the Pole, and escape before the storm broke. Half an hour later, he told Balchen to fly three miles to the right, circle left through 180 degrees, fly straight for six miles, and circle back. With much of its fuel gone, the Ford was far easier to handle and Balchen had no difficulty in doing this. Byrd opened a

trapdoor in the floor, and, without speaking, dropped out an American flag weighted with a stone from Floyd Bennett's grave, a Norwegian flag in honour of Amundsen, and a British flag for Scott. It was 1.15 in the morning, and the Ford was at 11,500 feet, just 3,000 feet above the bottom of the world in an air temperature of '15 below'.

They had done their job; but there still remained the long flight home. After the excitement and terror of the outward journey, it seemed to drag and, apart from a few anxious moments when Balchen could not find the pass through the mountains, all went well. They landed and refuelled from the cache of petrol at the foot of Mount Nansen and, soon after ten o'clock on the morning of 29 November, landed back at Little America.

For Byrd it was a proud moment, because he had become the first man to fly over both the North and South Poles. For Balchen, it was only the start of a career that has made him the world's greatest expert on polar flying, in an age when the North Polar routes hold the key to faster, cheaper air travel between the old and the new worlds.

CHAPTER NINE

A MAN NAMED MITCHELL

It is rare that a prize can change the course of history, and when, in 1912, Monsieur Jacques Schneider presented a trophy valued at £1,000 for a seaplane competition, he had little idea of the fierce international rivalry it would provoke, or that it would play its part one day in winning the greatest air battle of all time.

The trophy itself was—and is—a most unwarlike affair, made of silver bronze on a marble base, and consisting of the figure of a young man with graceful dragonfly wings, representing the breeze, swooping down to kiss the faces of four young ladies, symbolizing the waves. Depending on your point of view, it is either monstrous and useless or strikingly beautiful; but few people seem to think it decorative nowadays and less reverent members of the Royal Aero Club, where it is kept, have been known to hang hats from those slender wings, perhaps to prove that it is not quite useless!

The whole aim of Monsieur Schneider's generosity, which included cash prizes for the first winners, was to speed the development of safer, sturdier seaplanes, and for that reason some rather strict rules were worked out for the competition. The winner was to be the aircraft that achieved the highest average speed over a course of not less than 150 nautical miles, on a circuit of at least five miles. To ensure that the prize did not go to a freak high-speed aircraft of no practical use, all entries had to prove their seaworthiness before the speed contest. This involved mooring in the open sea for six hours, without sinking, after a series of take-offs, landings, and taxi-ing

The Schneider Trophy.

trials over the water that would certainly have shown up any faults in their floats or hulls.

As the years went by, the 'open sea' tended to become less and less open and salty: but even the aircraft that set up the highest speeds still had a very practical value, so the spirit of the rules was not lost.

The first contest for the Schneider Trophy was a feeble affair, added to the list of events at a seaplane meeting at Monaco in 1913. Only three aircraft competed and the winner was a French Deperdussin monoplane flown by Maurice Prévost, who failed to cross the finishing line properly, had to take off again, and so ended up with an average speed of 45.75 m.p.h.

The British Sopwith Company decided it was time to put some pep into the contest, and built a floatplane version of their little Tabloid biplane for the 1914 event, which was again held at Monaco. Its Gnome engine gave only 100 horse-power; but in the race, it soon passed its rivals that had taken off earlier, and speeded round the course at 86.78 m.p.h. After which its pilot, Howard Pixton, did two extra laps at 92 m.p.h. to set up a world seaplane speed record. This so shook the remaining competitors, from France and America, that they did not even bother to take off.

Because of the war, there were no more contests until 1919, when a meeting was held at Bournemouth and abandoned because of fog. Italy won in the following year at Venice, and again in 1921; so they needed only one more victory to gain the Trophy outright. Once more, British designers decided it was time they did something, and the Supermarine company sent a Sea Lion flying boat to Naples, where it formed the only opposition to the Italian Savoia and Macchi flying boats.

Its pilot, Henri Biard, decided to have a game with his rivals. In practice laps, he throttled back a little and banked clumsily round the turns, so that the Italians began to believe the Trophy was as good as won!

On the day of the race all three machines got away smoothly and started lapping the 18-mile circuit. As in all Schneider contests, it was not strictly a race, because the aircraft took off one after the other and were judged on their average time over the whole 230-mile course; but it was not long before Biard began passing the Italians, flying at up to 160 m.p.h. The hopes of the home team brightened after six laps, when he decided to nurse his engine a little, and Passaleva in the Macchi closed his lead from 25 to 20 seconds. But not for long, because on his thirteenth and last lap Biard really let the little seaplane go and romped home nearly two minutes ahead.

There was great joy in the British camp; but Supermarine's brilliant young designer, Reginald Mitchell, knew that they had been lucky to win. At a time when the world speed record stood at 212 m.p.h., it was obvious that something better than the Sea Lion would be needed for the 1923 contest at Spithead, and the answer came from across the Atlantic.

It heralded a completely new kind of competition, for America had decided that the Schneider contests brought so much national prestige that it was worth spending public money to make sure of winning. The result was the U.S. Navy's Curtiss CR-3 racing biplane, which set a completely new standard of sleek streamlined beauty. Its fuselage was the smallest, smoothest shell that could be wrapped around the powerful 465 horse-power Curtiss engine, and it made the British and French flying boats look like left-overs from another age.

Biard did his best in a Sea Lion, but could not get within 20 m.p.h. of the Americans, who finished first and second at over 170 m.p.h. So the Trophy crossed the Atlantic for the first time. But an answer to the American challenge was already taking shape in the Supermarine works, at Southampton, and it promised to outdo in beauty and speed even the Curtiss seaplanes.

The whole cost of Supermarine's Schneider Sea Lions had been paid by the company, with the help of Napier's, who made the aircrafts' Lion engines. After the 1922 victory, Mitchell had asked Napier's if they could produce a new racing version of this engine, giving up to 700 horse-power. They said they could, and he asked his directors if they would let him build around this power plant the 'cleanest' monoplane ever designed.

Although they knew it would cost a great deal of money, they had such faith in his ability that they agreed. Unfortunately, real aeroplanes, unlike those in Hollywood films, are not designed by one man in an evening on the back of an old envelope and then built in two or three months. There was no chance of having the new racer in time for the 1923 contest. Yet, perhaps this was just as well, for Mitchell was not afraid to admit that he learned something from the Curtiss machines.

When his own aircraft was completed, there was little doubt that the Americans could learn a great deal more from him. Nothing like it had been seen before. Known as the S.4, it was a tiny wooden monoplane, with no bracing wires or supports of any kind for its mid-set wings.

There had been no contest in 1924, so it was planned to send the S.4 to America in the following year. Before it left, it put up the world seaplane speed record to 226.752 m.p.h., despite its floats, which produced far more 'drag' than the wheels of a landplane, and English hopes were high.

They were dashed on the day of the eliminating trials for the contest at Baltimore, on 23 October, 1925, by the very feature that made the S.4 so far ahead of its time. As Henri Biard opened up its engines, the unbraced wooden wings began to flutter, and he crashed into the water. Luckily, he was not killed, but it enabled America to win the contest easily with a Curtiss R3C-2 biplane,

at a speed of 232.5 m.p.h. One more victory and the Trophy would stay in the United States.

However, the contest was given a new lease of life in 1926, when Italy staged a come-back with a Macchi monoplane that put the seaplane speed record up to 258 m.p.h. Like the U.S. machines, it was bought with Government money, and the Air Ministry realized that it could no longer turn a blind eye if Britain was to keep her place in the aircraft world. There was no question of merely wasting time and money on a stunt, because the lessons taught by the Schneider racers had already brought tremendous improvements in the design and construction of warplanes.

A special R.A.F. High Speed Flight was formed, and no fewer than seven specially-designed seaplanes were ordered for the 1927 contest, from three different companies. Supermarine's share was an order for three aircraft based on the S.4, but with braced wings and metal fuselage and floats. It was all that Mitchell needed to produce a world-beater; because this time he did not have to count every penny spent on the aircraft.

Never had any aeroplane been so finely tailored for speed as his S.5. Even the radiators were flush with the wings to reduce drag, and all the petrol was carried in one of the floats to offset the powerful swing of the propeller, which would otherwise have tended to spin the aircraft. Napier's boosted the Lion to over 900 h.p. and it was decided to fit a special version in one machine, with the propeller driven through gearing, so that it could turn more slowly and give improved engine efficiency. It was the first time that a high-powered geared engine had been produced, and had a tremendous effect on the future of aero-engine design.

Italy put up a good fight against the S.5 in the 1927 Schneider contest at Venice; but her Macchi seaplanes were outclassed. One by one they had to drop out with engine trouble, until finally the only aircraft left in the

air were two S.5's. By comparison with the spectacular flying of the Italians, who banked violently and shot high into the air as they rounded the pylons, losing speed every time they climbed, the R.A.F. pilots, Flt. Lieuts. Webster and Worsley, kept low over the water and made a beautifully judged bank at the very last moment. Webster's winning speed was 281.65 m.p.h., and later in the year Flt. Lieut. d'Arcy Greig raised the British national speed record to 319.57 m.p.h. in one of the S.5's. He actually flew faster than any other man in history, but did not beat the existing record by a sufficiently large margin for his speed to be counted as the world speed record.

After that nothing could stop Mitchell, and he intended to make quite sure of the record with his next design, especially as Rolls-Royce were developing a new engine that would give nearly twice the power of the Napier Lion. Then a big snag arose. The rules of the Schneider contest said that unless Britain defended the Trophy in 1928, France or Italy would have the chance of arranging the next contest, which would give them an advantage. But the Air Ministry made it clear that they could not afford to provide as much help in 1928 as they had in 1927. They could not even promise R.A.F. pilots to fly the aircraft. Could not the race be put off until 1929?

Wearing their best diplomatic smile, the Royal Aero Club, who were responsible for British entries and organization, wrote to the Federation Aeronautique Internationale in Paris, who control all international aviation sport and records. They suggested that, although it was obviously to Britain's advantage to hold the next contest in 1928, they believed that a one-year interval was no longer sufficient to enable new designs to be developed and was therefore prejudicial to progress. As holders of the Trophy, they did not feel they could press for a two-year interval, but would support any other country that proposed it.

The bluff worked, for the next meeting of the F.A.I. agreed unanimously that there should be a two-year interval between races in future. This gave Mitchell all the time he needed to build the world-beating S.6, in which Flight Lieut. Waghorn won the 1929 contest at Spithead, with an average speed of 328.6 m.p.h. A few days later, Sqd. Ldr. Orlebar set up a world speed record of 357.7 m.p.h. in the same machine.

Britain now had only to win the 1931 contest to keep the Trophy and, with an aircraft like Mitchell's S.6 to use as the basis for still newer racers, this seemed almost a certainty. But these were the years of trade slump and widespread unemployment, and the Socialist Government of the time did not feel disposed to spend £80,000, which they estimated would be the cost of putting up an R.A.F. team in 1931. At one stage, they even said that R.A.F. pilots would not be allowed to take part in the contest. Later, they reversed this on condition that all expenses were paid privately—carefully ensuring that there were only three days left in which this could be done.

They reckoned without Lady Houston, who promptly offered £100,000 to give Britain a fighting chance. There was no time by then to design anything very different from the S.6, but within six months Supermarine's had built two improved machines with Rolls-Royce 'R' engines that developed a fantastic 2,300 h.p.

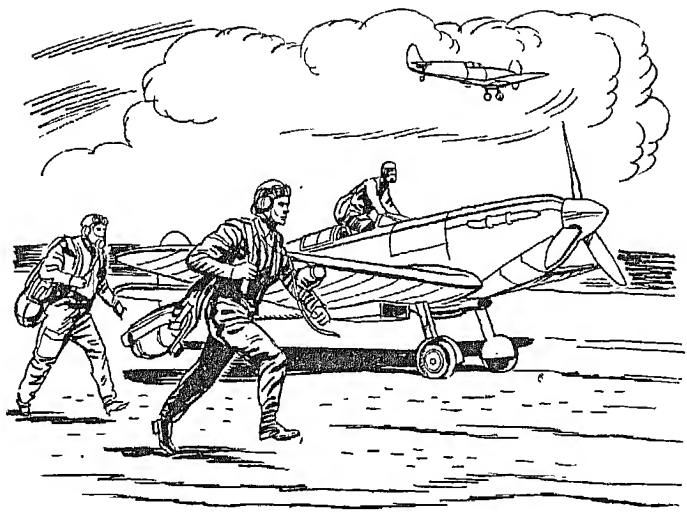
Even Rolls would guarantee these engines to run for only a few minutes at such a power, before burning out, and Mitchell had to put radiators all over the S.6B—on the upper and lower surfaces of the wings and on top of the floats. But there was hardly a doubt that they would win. Italian designers had been ordered by their Government to produce an engine to beat the Rolls-Royce 'R' at all costs. They tried hard; but their best was not good enough and, on the day of the contest, no Italian aircraft were ready.

Unchallenged, it was necessary only for Flt. Lieut. Boothman to fly over the course in an S.6B to make sure of the Trophy. He averaged 340.8 m.p.h.; but the aircraft's real capabilities were not shown until 29 September 1931, when Flt. Lieut. Stainforth put up the world speed record to 407.5 m.p.h., so becoming the first person ever to travel at more than 400 m.p.h. His speed record stood as a British record for fourteen years.

With the Schneider Trophy won outright, Mitchell's seaplane designing days were over, but he was determined that the experience gained should not be wasted. It seemed all wrong that the Royal Air Force should still be flying biplane fighters with a top speed of under 200 m.p.h., when his monoplanes, wearing great clumsy floats, could fly at twice that speed. So he designed a fighter plane to meet the latest Air Ministry requirements. When it flew, it was far bigger than he would have wished and had a speed of only 230 m.p.h. Believing that he knew what the R.A.F. wanted better than they did themselves, he scrapped this fighter, and started again, basing his new design on that of the S.6B.

As it took shape, it bore the stamp of his genius no less surely than had his racing seaplanes. It combined the slim fuselage of the S.6B with a pair of elliptical wings that seemed too graceful for a warplane, so that when the Germans first saw it they called it a toy. But inside the smooth nose was one of Rolls-Royce's new Merlin engines, developing 1,000 horse-power, and inside those pretty wings were eight machine-guns. No single-seat fighter had ever entered service with such power and punch.

Nothing was spared to make it the fastest, deadliest fighter in the world, and its smooth all-metal skin, retractable undercarriage and enclosed cockpit were all new departures for the Royal Air Force. Least of all did Mitchell spare himself. The little fighter was to be his masterpiece, and even as it took shape he knew that



The Spitfire flew side by side with the Hurricane to win the Battle of Britain.

his own life was drawing to a close. He lived long enough to see it fly and to know that it would be used by the Royal Air Force, before dying in 1937 at the age of 42.

For one so young, he had had many great moments, particularly in 1922, 1927, 1929 and 1931, when his racing seaplanes had won the Schneider Trophy contests for his country. It was tragic that he could not enjoy the greatest of all in 1940, when his little fighter, which he called the Spitfire, flew side-by-side with Sir Sydney Camm's Hurricane, to win the Battle of Britain and save the world.

CHAPTER TEN

DAWN OF THE JET AGE

ENGINE designers seldom share the great moments of fame and success that come to aircraft designers and pilots. Yet, from the earliest days of flying, the country with the best aero-engines has led the world. We remember engines such as the Antoinette, Gnome, Rolls-Royce Eagle, Hispano, Curtiss D-12, Napier Lion, Hercules, Merlin, and Gipsy, but forget the names of those who gave them form and life on the drawing-board and workbench—if, indeed, we ever knew them.

There is one exception, because this man's engine brought such enormous changes in aircraft design and performance that he has a place alongside the Wrights, Blériot, Roe, and all the other great pioneers who fill flying's hall of fame. He is, of course, Air Commodore Sir Frank Whittle.

It is not true that he invented the aircraft gas-turbine, because several people had suggested and designed gas-turbine engines to drive aircraft before he entered the picture; but none of them had achieved any great success. Nor is it true to say that he built the first jet-engine to lift an aeroplane off the ground, because the Germans were first to do that in August 1939. But neither their original aircraft nor its engine was developed into anything useful; whereas a high proportion of the jet aircraft flying today can trace their parentage back to Whittle's engine and the aircraft it powered on 15 May, 1941—at one of the very greatest moments in aviation history.

The story of events leading up to that moment takes a lot of beating as an example of how a person with a bright

idea and unlimited determination can find success, when the whole world of big business and official bumbling seem to be against him. Even when we leave out most of the squabbles and heartaches, it is still quite an adventure story.

Frank Whittle did not have the advantage of a rich home; but, after years of hard saving, his father had managed to buy a small engineering business, and he learned about mechanical things the practical way by helping at the bench during week-ends, evenings, and school holidays. When he was 15, he tried to join the Royal Air Force as an apprentice, but was turned down because of his height of only five feet. So he simply took a course of physical training which, within six months, gained him both the required extra three inches and an R.A.F. uniform. Already he was learning to get what he wanted by sheer hard work.

After three years as an apprentice, young Whittle was chosen for a cadetship at the R.A.F. College at Cranwell, and this was where the story of his engine began. Every cadet had to write a thesis (a kind of super essay) each term on some aspect of science, and in his fourth term he gave his ideas on 'Future Developments in Aircraft Design'. At a time when R.A.F. fighters were flying at about 150 m.p.h., he wrote of the day when speeds of 500 m.p.h. would be possible, at heights where the air was far 'thinner' than at sea level. Propellers and pistons would be no good, and he suggested the use of rockets or gas-turbine engines driving propellers, rather like a modern turboprop.

The whole purpose of getting people to write a thesis is to teach them to use their minds to sort out all the arguments for and against a particular subject, and Whittle's interest did not end when the writing was finished. Towards the end of 1929, when he was posted to the Central Flying School for training, he was still trying to figure out a power plant for that 500 m.p.h. fighter of

the future, and by then he had begun to think in terms of jet-propulsion.

Here, perhaps, it is as well to point out that even a propeller-driven aeroplane uses a form of jet-propulsion, because it moves forward by flinging to the rear a fat column of air with its propeller. A simple gas-turbine (or jet-engine if you prefer) flings back a narrower column of air at a higher speed to achieve the same results.

The first type of jet-engine he considered was a combination of the two, and consisted of little more than a piston-engine driving a propeller or fan *inside* the aircraft's fuselage. Extra power was to be obtained by burning fuel in the compressed air pushed rearward by the fan, before it left the jet outlet at the tail: but even then, this type of engine (known as a ducted fan) seemed to offer little advantage over an ordinary piston-engine driving a propeller. So he rejected it.

Ten years later the Italians built a jet-plane with this kind of power plant, and reached the same conclusions as Whittle when it flew at only 233 m.p.h.

By then, he had made progress beyond his wildest hopes of 1929; because soon after deciding against the ducted fan the idea had come to him of using a turbine instead of the piston-engine. The result was very like the primitive turboprop he had mentioned in his thesis, but far simpler because it merely flung back a column of air instead of driving a propeller.

He told one of the C.F.S. instructors of the idea and was soon on his way to explain it to Air Ministry technical experts. All his hopes were dashed when they pointed out that no metals in the world would withstand the sort of heat produced inside a jet-engine, and he returned to the C.F.S. feeling very crestfallen.

Fortunately, the instructor, Flying Officer Johnson, was not only one of the finest pilots in the Royal Air

Force, but an ex-patent agent. He helped Whittle to patent his designs, in the hope that new developments in metals might change the whole picture one day. Unfortunately, the patent could not be put on the secret list, because of the Air Ministry's lack of interest and, after about eighteen months, its details were published for anybody overseas to copy. But this did not seem to matter very much at the time, because there was little prospect of ever building the engine. The British Thomson-Houston Company had told him it would cost at least £60,000, and he had so little spare cash that he could not even afford to renew the patent when the time came.

As some consolation, he was able to take first an officers' engineering course at Henlow and then a degree at Cambridge University; for the R.A.F. had begun to realize by then that this young man was something of an engineering genius, despite his rather odd ideas on aero-engines.

While he was at Cambridge, he received a letter from a friend named Dudley Williams, who had been a fellow cadet at Cranwell and had since left the R.A.F., saying that Williams had just met one of the chiefs of an engineering concern that might be interested in his ideas for a jet-engine. Whittle met Williams and another ex-R.A.F. officer named Tinling, and their staunch friendship over the next few years was one of his greatest assets.

As a start, they introduced him to M. L. Bramson, a Dane who had lived in England for many years and become a naturalized British subject. Being both a pilot and a fine engineer, Bramson soon became enthusiastic about Whittle's proposals and took him along to the banking firm of O. T. Falk & Partners, who agreed to put up the first £2,000 to form a company to build not only the engine but a complete jet-propelled aeroplane. They named the company Power Jets Ltd., because this

seemed to fit in with its purpose, without giving away too much.

The fact that Whittle was a serving officer of the Royal Air Force complicated matters. The Air Ministry were not entirely unco-operative, but they insisted that his work for Power Jets must be very much part-time, involving not more than six hours' work each week, and that the Air Ministry must have the right to make free use of his patents and inventions. This did not seem a very good idea when they were likely to be the main customer one day: but he had no choice, and hoped it would sort itself out in due course.

Once again Whittle went to see the British Thomson-Houston Company, and this time they agreed to produce the design drawings for the engine under his guidance, and to build it, provided they were paid monthly for their work. Whittle had hoped to build the engine a piece at a time, testing each carefully before assembling it: but this soon proved to be impossible, because it would have cost £27,000 to construct the 3,000 h.p. equipment needed to test the engine's compressor alone.

Power Jets never had enough money to do the job as they would have wished: but they made up for this in enthusiasm and hard work. They believed they could build the first engine for as little as £5,000 because, basically, an aircraft gas-turbine is an extremely simple affair with only one moving part—a shaft which has a compressor wheel at its forward end and a turbine wheel at the rear. All that happened in Whittle's engine was that air entered a hole at the front, was flung sideways and compressed by the blades of the compressor, and mixed with fuel and burned in a combustion chamber between the compressor and turbine. The mass of hot gases produced by the combustion raced towards the hole at the rear of the engine, spinning the blades of the turbine as they passed by. As the turbine was attached to the same shaft as the compressor, this turned the

compressor too and kept the whole process going, with the shaft spinning, it was hoped, at about 17,750 r.p.m. (revolutions per minute). This, they calculated, would be sufficient to give a small transatlantic mailplane a speed of 500 m.p.h., which is rather interesting, because Whittle had originally thought mainly in terms of jet-powered fighter 'planes.

It was obvious from the start that most of the serious problems would result from failure of metal parts under the terrific heat and stresses produced inside the engine. If the Air Ministry had realized the possibilities of the engine, it would have been different, because the research programme that produced Britain's world-beating Nimonic alloys and other metals during World War II would have been started years earlier. But they did not, and at times even Whittle became depressed at the slow progress.

The Air Ministry were co-operative to the extent that, after he had obtained his degree at Cambridge University, they agreed to let him spend a year on research, which meant he could devote almost all of his time to working on the engine. After that, they put him on the special duty list of the Royal Air Force, which made development of the engine officially his full-time job.

The first parts of the prototype engine were made in the summer of 1936, and towards the end of the year tests began at the B.T.-H. works at Rugby to find out if it was possible to produce the intensity of combustion needed in the engine. These tests were made in the open air, under some offices, and soon there were well-justified complaints from the occupants. Their rooms became filled with clouds of choking fumes, the noise deafened them and the vibration made papers, pens, ink, books, and everything else 'walk' off their desks onto the floor. Little wonder that, after a time, the work was moved from the main factory to a disused foundry a few miles away at Lutterworth.

Just before this move took place, on 12 April 1937, came the great moment when the first engine was ready for test. Gradually its speed was increased from 1,000 to 2,000, then 2,500 revolutions a minute. Suddenly, the noise grew to a piercing shriek and the B.T.-H. men, who had seen the dreadful consequences of a turbine running away and flying to pieces, began dashing for safety. Quick as a flash, Whittle closed the throttle valve, but it made no difference and the engine raced away to 8,000 r.p.m. before slowing of its own accord.

Despite the mishap, which was traced eventually to a fuel system fault, the Air Ministry could no longer fail to show an interest in the engine, especially as there were rumours that the Germans were also working on jet aircraft. A first official contract worth £5,000 was signed in March 1938, just in time to prevent a financial crisis that would have brought the entire project to a halt. It was not by any means the last crisis; but Air Ministry support was the only factor that had been needed to ensure eventual success.

The first jet-engine was a strange-looking affair. Its combustion chamber curled around it and the whole thing looked rather like an overgrown and neglected brass band instrument. Later, its single combustion chamber was changed for a ring of ten smaller ones around the outside, and the result began to look more like the engines of today. But the work of perfecting it proved far more difficult and took much longer than expected, and even Whittle became downhearted at times. Not until June 1939 did the engine show its true possibilities by running at 16,000 r.p.m. under perfect control.

The method used to measure its power was a flashback to Cody's tree of 1908, because the engine was mounted on a wheeled trolley, and linked by a spring balance to a post embedded in the floor, to measure its thrust.

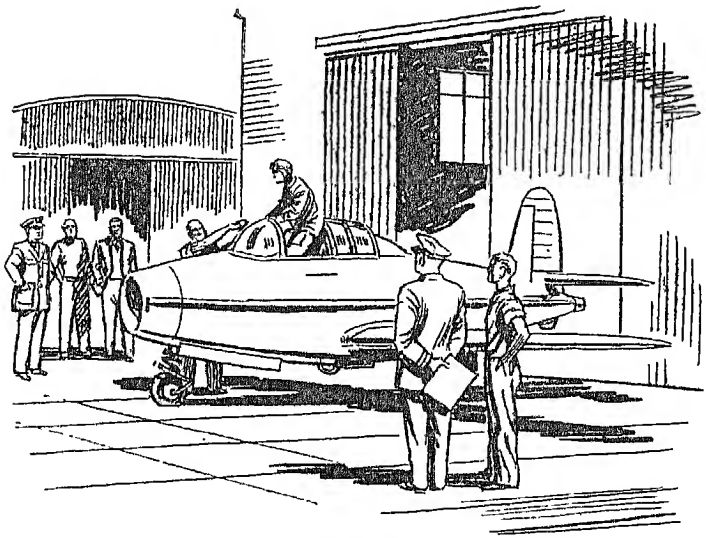
The Air Ministry were now so convinced that the

Whittle engine would be a success that they ordered one suitable for flight testing and gave the Gloster Company a contract for an aeroplane to fit it in. Power Jets had hoped to be given the contract for the aircraft themselves, so that by sub-contracting its construction they could control its design and development; and this was only the first of many disappointments. The greatest came much later when the Air Ministry refused to let them produce their own engines in quantity, so that they had to remain a design and research company. But this did nothing to lessen their great achievement in developing jet-engines to the stage where other firms could take them over for mass-production.

Plans to build great numbers of Whittle engines were made even before the flight engine (known as the W.1) and the Gloster E28/39 aircraft were completed; because the war was on and the Air Ministry could not wait to be 100 per cent certain that they would work. Power Jets were given a contract to design a more powerful engine designated W.2 and, in October 1940, it was planned to built 160 of these engines a month, to power a monthly output of 80 Gloster-built twin-jet fighters. This was the start of the aircraft we know now as the Meteor: yet the first flight of the E.28/39 was still many months away and there were plenty of experts who believed it would prove a flop, or even dangerous to fly.

To speed development, a second engine known as the W.1.X was assembled in December, 1940, mainly from parts of the W.1 that had been scrapped. Up to then Power Jets had had only their one experimental engine to work with and this, coupled with the fact that their total payroll, including Directors, was only 25 at the beginning of 1940, had certainly not helped progress.

By April 1941, the E.28/39 was ready for testing; but its W.1 engine had not been run. So the W.1.X was sent to Gloster's to power the aircraft during its taxi-ing trials. On the evening of 7 April, the company's chief test pilot,



The chief test pilot climbed into the cockpit of the tiny, strange-looking monoplane.

P. E. G. Sayer, climbed into the cockpit of the tiny monoplane, which looked strange squatting on its short undercarriage, and with a hole where the propeller was fixed on a normal aircraft. On an aerodrome soggy with rain, it began to move forward, its engine shrieking a high-pitched whine; but its speed stuck at 20 m.p.h. and when he brought it back Sayer was tremendously disappointed and quite certain it would never fly.

Whittle and his engineers from Power Jets did not share his fears, because the throttle had been set to keep the engine speed down to 13,000 r.p.m. Next day, it was opened up to 16,000 r.p.m. and, although the engine could not be taken into the air, being the 'scrap' W.1.X, Sayer was so delighted with its performance that he lifted the aircraft off the ground in a series of 200-300 yard hops.

Soon the W.1 itself was ready, and trial runs on the ground had shown that it would develop a thrust of 1,000 lb. at 17,000 r.p.m. To give an extra margin of safety, it was cleared for flight at a thrust of 860 lb. at 16,500 r.p.m., which gave the E.28/39 slightly less power than an early Spitfire fighter.

The taxi tests had been made from Gloster's grass airfield, but a paved runway was essential for the first proper test flights and the E.28/39 was taken to Cranwell. No more appropriate place could have been chosen, for when this little aircraft, piloted by Sayer, left the ground on 15 May 1941, to make a perfect 17-minute flight, it was within a stone's throw of where a young cadet had written a thesis on 'Future Developments in Aircraft Design' thirteen years before. Now, that same cadet had made possible speeds of not merely 500 m.p.h., as he had hoped, but performance that would one day enable aeroplanes to outfly the sun on its 1,040 m.p.h. journey round the equator.

CHAPTER ELEVEN

THE DAM BUSTERS

THERE are no prouder stories in the world than those which tell of battles against tremendous odds by little bands of men fighting for what they believe to be right. The Greeks at Thermopylae, Henry V's army at Agincourt, Sir Richard Grenville in the *Revenge*, the Light Brigade at Balaclava, the famous 'Few' of the Battle of Britain—all these, and many others, lived on in the finest pages of history, even when they gave their lives to write them. To the list of great names was added, on the night of 16-17 May, 1943, that of No. 617 Squadron of R.A.F. Bomber Command—the 'Dam Busters'.

Even today their full story cannot be told, for the strange weapon they used to add flood to the fire and explosion that were smashing the enemy's fighting machine is still secret. In an atomic age, it has not yet been surpassed as the means of achieving its special kind of destruction.

Nor, in remembering the deeds of No. 617 Squadron must we forget the name of Barnes Wallis, for it was this grey-haired, gentle scientist who made the whole job possible. Already famous as the designer of the R.100 airship and the 'wicker-work' metal construction that had made the Wellington bomber so successful, he began in 1940 to plan a series of mighty bombs to hasten the end of the war. Unlike the old-fashioned, heavy-cased bombs used then by the R.A.F., they were to be streamlined giants, weighing up to ten tons and designed to explode far beneath the surface of the ground so that they destroyed as an earthquake destroys, by shaking the earth rather than by blast.

He even chose targets for his 'block-busters'—the great Moehne, Eder, and Sorpe dams that supplied almost all the water used in the Ruhr valley, heart of Germany's war industry. No bomb ever built could harm the great concrete walls of the first two, which were more than 100 feet thick in places. Yet, if they could be breached, the hundreds of millions of tons of water they held back would be unleashed, sweeping across the towns and villages of the western Ruhr and crippling the war factories, which needed a vast regular supply of water to produce their steel.

Like most new ideas, it was not welcomed at a time when Britain was stretched to the limit to build sufficient ordinary weapons for survival. But at last the Ministry of Supply agreed there might be something in the idea and formed a committee to study Wallis's plan.

He knew he would have to show facts and figures to prove that his big bombs would work and, with the help of Dr Glanville of the Road Research Laboratories, he built a perfect model of the Moehne dam from tiny blocks of concrete. When completed, it was more than 30 feet long, with a pool of water behind it to represent the lake held back by the real dam, and there was no doubt that it would behave in exactly the same way when scaled-down 'bombs' were exploded near it.

Eagerly, Wallis and Glanville buried a few ounces of gelignite into the earth four feet from the model dam, to discover what the effect would be if a 10-ton bomb exploded 200 feet from the real thing. When the water subsided, the concrete was hardly chipped. Even when charge after charge was set off from a distance of 12 inches, which would have required an impossible R.A.F. bomb-dropping accuracy of 50 feet, the concrete was only cracked. Obviously, the whole scheme was hopeless and Wallis wondered what he would say to the committee.

But was it really so hopeless? If bombs could be ex-

ploded close up against the face of the dam, they would certainly do the job. Unfortunately, torpedoes were out, because the Germans had rigged protective nets in front of all their big dams, and there seemed no other way of getting the explosive charges where they would do most good.

Then he remembered the game his children used to play at the seaside. They called it 'ducks and drakes', sending flat stones skimming in a series of hops over the surface of the water until, all their speed gone, they sank slowly down. Why could not a bomb be made to skim the surface of the Moehne and Eder Lakes in the same way, and then sink against the dam walls to just the depth where the shock of the explosion would do most damage?

He began carving model bombs of strange shapes from small lumps of wood and skimming them across a tub of water in his garden. When they seemed about right, he went back to the model dam and tried exploding small charges of gelignite against the wall under the water. This time there was no question of success, for charges equivalent to a real bomb of 4½ tons weight tore gaping holes in the six-inch thick concrete. But he knew that this was a very different matter from making a real bomb of the kind he had designed and proving that it would blow up a real dam.

First he checked his calculations by smashing a small unwanted dam in Radnorshire with an ordinary explosive charge; then tested many more models of his bomb in the test tanks of the National Physical Laboratory, where their behaviour could be photographed both on the surface and under the water. Finally, he was allowed to make some half-scale models of the weapon and drop them from a converted Wellington bomber.

Just as everything seemed to be going fine, the Ministry of Supply decided to cancel the whole idea. Equally suddenly, a week later, they told him that it was to go

ahead, and that he had just three months in which to design, build, and test his full-size bombs, so that the attack on the dams could be made during May, when the water level would be at its highest.

By mid-April, a batch of the weapons had been made and Wallis drove out to the deserted beach at Reculver to watch the first full-size tests. A Lancaster bomber swooped in low over the sea and dropped from its bomb-bay a monstrous shape seven feet wide that smashed into the water with a great splash and immediately broke into a dozen pieces. Later in the day, a second test with a strengthened bomb was more successful; but the third bomb, dropped a week later failed to work, and there were only three weeks left in which to get the thing right. Not until 29 April was the fourth ready and Wallis held his breath as it dropped from the Lancaster and hit the water. A fraction of a second later, it began behaving like no other bomb ever built, seeming to lob over the water at high speed like some great black ugly insect.

Success now depended on the ability of the crews of No. 617 Squadron, which had been formed in the previous month for the sole purpose of making this one raid. They represented the cream of Bomber Command, all hand-picked by their leader, a 25-year-old Wing Commander named Guy Gibson, who had flown the incredible total of 173 sorties and wore the ribbons of the Distinguished Service Order and Distinguished Flying Cross on his uniform. At that time, any member of Bomber Command who completed a full tour of thirty operational flights could count himself both lucky and superbly skilled. To have survived 173 'ops' made a man seem super-human, and the handsome, gay Wing Cdr. Gibson was regarded with a rare mixture of affection and respect by all who served with him. They knew only that the mission for which they were training was something special and highly dangerous. They had no idea what it was; and yet did

not worry—Gibson was leading them, so everything would be all right.

Day after day they practised low flying in their great four-engined Lancasters, because they had been told that the attack for which they were training was to be made at a height of exactly 60 feet over water. Forty feet or 80 feet would be no good: their time and, probably, their lives would be merely thrown away. When Gibson considered them good enough, they began doing the same thing by night. It was often difficult to tell where sky ended and water began, and Lancasters began to return to the airfield at Scampton in Lincolnshire with branches from trees stuck in their radiators.

It seemed as if the whole operation might be ruined by the impossibility of judging height accurately as the big bombers streamed in to their target at 240 m.p.h. Then someone suggested fixing a small spotlight under the nose of each aircraft and another under the centre of the fuselage, so that their beams crossed exactly 60 feet below. Then, if they flew above or below that height they would see two spots of light on the surface of the water and would need only to climb or dive until the spots merged to hold an exact 60 feet. It was simple, and yet it worked perfectly. So did the bombsight, which was little more than a piece of plywood with a peephole at one end and two nails stuck in the other end, the idea being to drop the weapons when the nails lined up with towers on the tops of the dams. More days of intensive practice, and then the Squadron was ready.

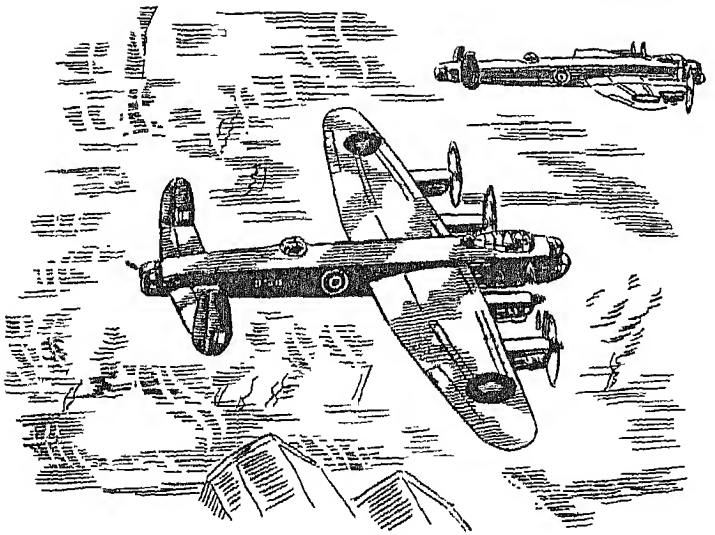
On the afternoon of 15 May, all the pilots, navigators, and bomb aimers were called by radio to the briefing room, and within a few minutes they knew the targets that they had trained so hard to destroy. They inspected models of each of the dams, based on photographs brought back day after day by Mosquito photo-reconnaissance aircraft and so beautifully made that they could study the best course in to each of the difficult

targets, knowing that the shapes they saw as they bent low over the models were exactly what they would see as dark silhouettes against the night sky from the cockpit of their Lancasters. The main difference was that in all probability the sky would then be filled with anti-aircraft fire from guns mounted around the dams, and they knew they would make easy targets flying straight and level at exactly 60 feet.

When a red flare whistled into the air from Gibson's Lancaster just after nine o'clock on the following evening, there were 19 aircraft of No. 617 Squadron lined up for the raid. This was the moment for which the Squadron had been formed, and as the first bomber began to move down the runway, with a monstrous black shape clutched under its fuselage, 133 young airmen began to lose a little of the tension they had felt for days. Only a few hours more and it would all be over. Life could settle back into the old routine of ordinary raids with ordinary bombs—at least for some of them.

First to leave were the five aircraft chosen to attack the Sorpe dam. Led by an American named Joe McCarthy, they were to follow a longer, more northerly route than the main force of nine aircraft under Gibson, to split the enemy defences. Not until two hours after this force had taken off were the remaining five aircraft to leave, and their job was to smash any dam that survived the first attacks.

Because his own Lancaster had become unserviceable, McCarthy had had to switch to another aircraft at the last minute and had taken off twenty minutes after the other members of his flight. Desperately, he raced over the North Sea to catch them up; but it was already too late. Of the four aircraft, one had been so damaged by anti-aircraft fire that it was forced to turn back; another had hit the water, tearing off its bomb and was also limping back to Scampton. The others had been shot down.



Gibson's nine aircraft were flashing over the Dutch countryside at a height of 40 feet.

Further south, Gibson's nine aircraft were flashing over the flat Dutch countryside at a height of 40 feet in three 'V' formations. One got slightly off course, and was never seen again. The other eight roared on as fast as they could with those great black shapes slung under the fuselage. In the cockpit of 'G for George', Gibson's tense excitement was mingled with a sadness he could not shake off, for a few hours before take-off his dog 'Nigger', which had been far more than a mere pet, had been run over and killed. Yet he would share his master's triumph, if there was a triumph, because the radio message signalled from the skies over the dams to England, reporting success, was to be the one word 'Nigger'.

Over Germany now, and the anti-aircraft fire became more intense. Turning and twisting, flying around areas

where guns were known to be packed almost muzzle to muzzle, they flew ever nearer to their target. A change of course, and there ahead, the moonlight glinting on its lake, was the Moehne dam.

Round in a wide bank and Gibson's aircraft picked up speed as he put it into a shallow dive towards the shining surface of the lake. Dark hills loomed up to each side. Below the twin circles of light from his spotlights slowly closed together. Ahead, the concrete face of the dam flashed and sparkled as the enemy gunners tried to sight on the great aircraft streaking towards them at 240 m.p.h., exactly 60 feet above the lake. Through the hail of shells and bullets, Gibson held the Lancaster firmly and steadily on course. In its nose, his bomb-aimer watched the towers on the dam starting to overlap the nails on the bit of plywood upon which success depended. He hardly needed to shout 'Bomb gone'. Relieved of its 4½-ton load, the bomber seemed to leap up and away, over the dam, and then weaved viciously from side to side as Gibson tried to dodge the gunfire that streamed after them.

Behind them, as the shock of the explosion died away, the second aircraft was already roaring down to attack the badly-damaged dam. Gibson watched it racing in over the lake, seemingly surrounded by coloured streamers of shells and tracer bullets. Suddenly, a larger, brighter glow lit the surface of the lake. Still the bomber flew on but, almost in a second, it was all over; with nothing but a few brightly burning fires where there had been a fine aeroplane and its crew of seven young men a fraction of a second earlier.

As the third bomber dived towards the lake, Gibson circled down to divert the attention of some of the enemy gunners. It worked, and this time as the Lancaster climbed away there was a great fountain of water against the dam. Still it held and Gibson began to wonder if Wallis's calculations had been wrong. Two more crews followed,

As the Lancaster climbed away there was a great fountain of water.

while the aircraft that had already attacked circled round to split the defences.

The sixth Lancaster moved into position to start its dive into the hail of brightly-coloured shells. But this time there was no need, for millions of gallons of water were already streaming through a jagged 100-yard gap in the smooth concrete, sweeping away trees, houses, everything else in their path as they rolled in a towering wall of foaming fury through the narrow valley in front of the dam.

From Gibson's Lancaster a wireless message flashed back to England—'Nigger'—and a group of dignified Air Marshals almost danced with joy. Wallis did.

But the job was not yet over, for the aircraft of Gibson's force that had not yet dropped their bombs were now on their way to the Eder dam, where the concrete was even thicker than that of the Moehne. This time there were no guns, but they were hardly needed, for the lake was set in high mountains and, as it came in sight, there was a swirl of light mist over the water.

The first Lancaster dived in to attack, but was soon climbing again, trying desperately to miss the cruel jagged mountain walls. Six times its pilot tried to get into position—60 feet, 240 m.p.h.—and six times he succeeded in averting a crash by a hairsbreadth. A second aircraft followed, only to find the same difficulty, and it began to look as if the Eder would win. Again the Lancaster flew around, down across the lake and this time its bomb was launched. There was a blinding flash as the bomb, the parapet of the dam, and the aircraft disappeared together.

The first crew tried again, and again, and this time its bomb hit the dam fair and square; but it had taken four to breach the Moehne. One could hardly destroy the thicker Eder, and there was only one more aircraft left to attack. As it dived in, the other crews felt as tense as when, what seemed days ago, they had left Scampton.

And when the whole dam seemed to explode outwards with fantastic force, they all felt like doing victory rolls, even in four-motor bombers.

McCarthy and one of the reserve crews hit the Sorpe dam. Another tried, but could not find it in the mist and returned home with his bomb. Yet another attacked the smaller Ennerpe dam. The remaining two simply flew out into the night sky and did not return.

Of the 19 Lancasters that had taken off from Scampton, only eleven had returned when the dawn began to tinge the sky. Behind, in the Ruhr, lay a scene of watery desolation and destruction. Ahead was a short, well-earned leave, a Victoria Cross for Guy Gibson, a string of other decorations for those who had survived—and then more operations, from one of which Guy Gibson, V.C., failed to return.

CHAPTER TWELVE

THROUGH THE SOUND BARRIER

THERE was no doubt in 1947 that the sound barrier was a killer. Pilot after pilot had died when the wings or tails of their fighter 'planes had been ripped off for no apparent reason during high-speed dives.

Designers knew that their enemy was the invisible, seemingly harmless air, which became so compressed by the speeding aircraft that it formed almost solid shock waves that hammered the structure until it broke up. They knew, too, that the shock waves formed when the air flowing over the 'plane approached the speed of sound, which is 760 m.p.h. at ground level, dropping to 660 m.p.h. above 36,000 feet. It was possible to gain a few extra precious miles-an-hour by sweeping back the wings like an arrowhead and by making them thinner: but it seemed as if aircraft might never be able to fly safely above 650 m.p.h. and the newspapers began writing about the 'sound barrier' to higher speeds.

In England, all work was stopped on a bullet-shaped research aircraft designed to fly at 1,000 m.p.h. Pilots protested, but the Government said it was too dangerous for men to slam deliberately into the sound barrier, and began playing instead with rocket-powered models, launched in mid-air from Mosquito bombers. Only in America did very high-speed research flights continue with piloted aircraft, and even there no attempt was made to crash headlong through the barrier.

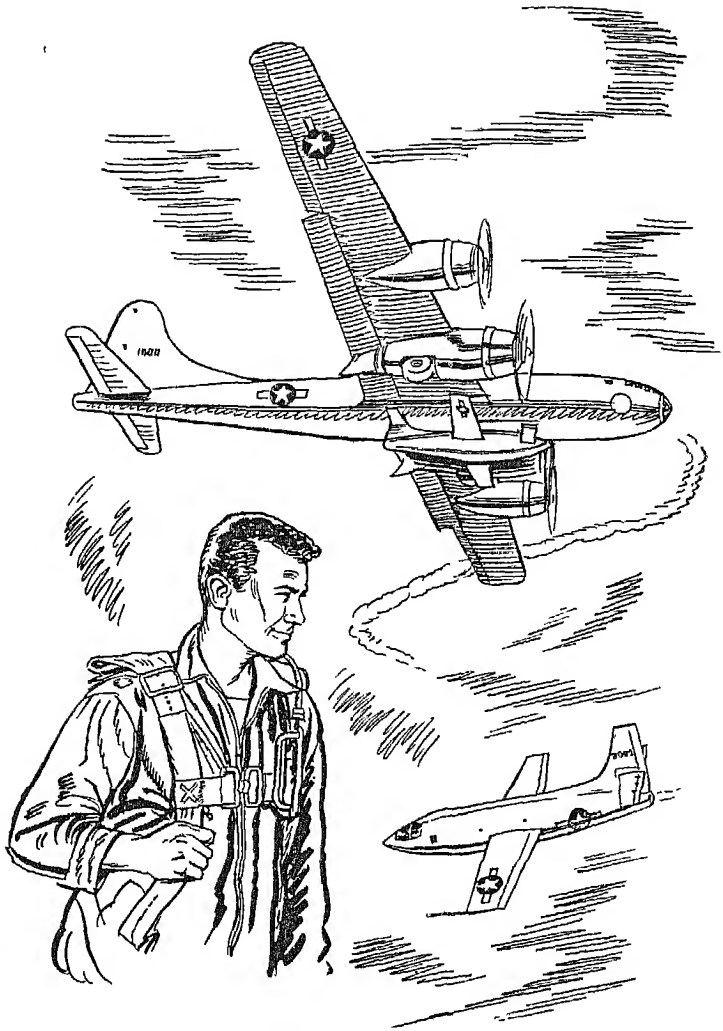
The Bell company had built a remarkable rocket-powered aircraft known as the X-1 (experimental No. 1),

which they calmly announced would fly one day at nearly 1,700 m.p.h. Most people regarded this as just a tall story; one of the few who believed it was a 24-year-old U.S. Air Force pilot named Captain Charles ('Chuck') Yeager. Perhaps this was just as well, because he was the man chosen to try and crack the sound barrier in the X-1.

By 14 October 1947, he had flown nearer to the speed of sound than any man still alive, gaining a few miles-an-hour on every test flight, until he had reached what technicians and pilots call Mach .94 (94 per cent. of the speed of sound). He had felt his aircraft bucking under the hammer blows of shock waves that would have smashed anything else in the air. But he had unlimited faith in its thick metal skin and in the wings, which looked so small and were only 3½ inches thick yet could support a weight equal to the biggest aeroplane ever built.

As he waited inside the four-motor Superfortress bomber that was climbing slowly into the air above the U.S.A.F.'s secret research base in the Californian desert, he knew that his life depended on whether the X-1 deserved that faith. Its streamlined orange-coloured shape could be seen clutched half inside the cut-away bomb bay of the Superfortress, which would launch it like a bomb at a height of 20,000 feet, to save fuel. This was essential, because its four-barrelled rocket motor was so powerful that it burned all the aircraft's six tons of fuel in only 2½ minutes at full throttle.

Soon it was time to get aboard. Trying not to look down at the ground more than a mile below, Yeager walked along a narrow catwalk in the bomb-bay, jumped onto an extending ladder suspended in space, and clambered sideways from it, into the cramped cockpit of the X-1. He locked the door in place and began checking all the instruments and controls. Although he could still talk to the crew of the Superfortress by radio, this was the worst moment of all, feeling closed in and helpless in



The streamlined shape of the X-1 could be seen in the bomb-bay of the Superfortress, which would launch it like a bomb.

the darkness of the bomb-bay and with the freezing cold of the liquid oxygen fuel beginning to penetrate his thick, heated flying suit.

After an endless forty minutes came a warning signal from the pilot of the Superfortress: '*Five minutes*'. Yeager started re-checking the vital equipment—oxygen turned on and cabin pressurized so that he could breathe above 40,000 feet where his lungs would be useless without artificial help, parachute firmly fastened, undercarriage locked up, rocket motor switches off.

'*Four minutes.*'

A glance at the windscreen, so streamlined into the shape of the bullet-nose that he had little forward or sideways view. It had been rubbed over before take-off with hair shampoo to stop it steaming up. Strange that a little thing like that might make all the difference between a safe flight and . . . .

'*Three minutes.*'

The jet fighter 'chase planes' were moving into place, ready to check that everything looked right as he dropped away from the big bomber, and to keep him in sight for as long as possible during the flight. He heard them reporting their positions. One was so very close—just on the other side of that dark bomb-bay wall.

'*Two minutes.*'

Time now to make the final adjustments to the fuel system, to make sure it would all work if something went wrong and the liquid oxygen and alcohol had to be dumped in a hurry. There would be little future in trying to land with six tons of them on board. It was tricky enough without.

'*One minute.*'

In just sixty seconds would come the climax to four years of flying, during which Yeager had fought against the German Air Force in Europe, been shot down, escaped back to England, destroyed twelve enemy aircraft, and won a string of medals. But there was no

time to think of such things, for the Superfortress pilot was already counting 'Ten, nine, eight, seven, six, five, four, three, two, one . . . DROP'.

Brilliant sunshine suddenly flooded into the X-1's tiny cabin. Yeager felt helpless, as if he were riding blindfold on a roller coaster that had broken away from its rails. His whole world was silent, except for the whir of a ciné-camera photographing the instrument panel over his shoulder. Automatically, he eased back the control column, felt himself no longer floating in space, and gradually sight returned. It was time to fire the first barrel of the rocket motor before the X-1 lost precious height. A kick in the back as it fired and the X-1 began to accelerate, no longer silent. Each motor had to be tested in turn. So did the controls.

Then, all motors on for a screaming full-power climb to 35,000 feet and, again, two motors cut as he levelled off at 40,000 feet. Mach .92 now, straight and level, but the X-1 was beginning to buffet and no longer felt stable. It was too late to change his mind. Yeager pulled back the stick and fired the shut-down rockets. Any second now the designers and scientists eight miles below would know if the sound barrier was solid. If the X-1 smashed itself against the 'brick wall in the sky', it was fairly certain that no other aeroplane would get through.

The needle on the Mach-meter started to swing. . . . .94, .96, .98 and now the X-1 was beginning really to go. Instead of getting worse, the hammering stopped; but the Mach-meter suddenly went crazy, swinging right off the dial and back. Calmly, he reported it to the chase-'planes, then switched off the rockets. The X-1 glided on up to 45,000 feet, nosed over and began the long spiral down to base, where the longest runway in the world stretched for miles over the flat desert. As the wheels touched, Yeager glanced at the time. It was just fourteen minutes after the X-1 had dropped from the Superfortress.

In that time, history had been made and the sound

barrier robbed of much of its terror, for he had reached Mach 1·05, comfortably past the speed of sound, and held it for several seconds without difficulty. In fact, but for that flick of the Mach-meter, caused by the shock-wave passing over the probe that made it work, it would have been difficult to tell the moment when he went through the 'brick wall'.

Because of what he had done, aircraft designers were able to start again on a completely new generation of fighting 'planes that used lessons learned with the X-1 to follow it into the world of smooth, controlled flight above Mach 1. There was still much to learn, and the U.S. Government poured many millions of pounds into supersonic research, building great wind tunnels, laboratories, and new aircraft to take over where the X-1 left off. In Yeager's hands, it had gradually built up its speed to reach a peak of 967 m.p.h. Now there was a newer version known as the X-1A, which promised to fly even faster.

At first glance, it looked little different from the X-1. It was five feet longer, its metal a polished silver instead of orange and its cockpit 'stepped' to give the pilot a better view. But there were more important differences inside, with larger fuel tanks and special pumps that would force fuel into the rockets at a higher rate. The result, claimed its makers, would be longer endurance and far higher speed. Once again, it was up to 'Chuck' Yeager to prove them right, and he no longer had to beat just his own 967 m.p.h., for test pilot Bill Bridgeman had hit 1,327 m.p.h. in the U.S. Navy's Skyrocket research 'plane. Never had the rivalry between the U.S. Air Force and Navy been more keenly felt and, although the test flight on 12 December 1953 was routine, Yeager hoped it might be his fastest yet. It was—and it was also very nearly the last flight he ever made.

All went well at first. The X-1A dropped cleanly from its mother-plane at 30,000 feet. He fired three

barrels of his rocket-motor, climbed steeply to 45,000 feet, cut in the fourth barrel, and began streaking up in an arc to over 70,000 feet, dwindling so rapidly that the chase 'planes lost all sight of him.

Inside the cockpit, Yeager almost began to wish he hadn't such a good view, because he could see the tiny wings buffeting with the shock-waves on them. The skin became scorching hot as the aircraft forced its way through the air; but a refrigeration system kept the cockpit cool. No previous flight had been like this. The whole machine was being hammered by buffeting so hard that it was difficult even to think straight, except to notice that the Mach-meter had climbed higher than ever before.

Then the fuel had all gone: but the X-1A continued to hurtle up, gradually slowing and bucking so violently that it was difficult to control. It was nearly down to Mach 1, still climbing, when Yeager suddenly knew that he was no longer flying the aeroplane. Desperately, he fought to regain control; but it was hopeless. Out of control in the thin air, it began tumbling crazily towards the ground, slamming him from side to side of the cockpit so hard that the inner lining of the pressure cabin was split. If the outer shell had gone too, his blood might have started to boil. But what did it matter when it seemed certain he was going to die anyway?

The outer skin was still scorching hot, the controls useless and, with no ejector seat to throw him clear of the tumbling aircraft, there seemed no way out. He felt as scared as when the German Focke-Wulfs had shot his fighter to pieces over France. But then he had been able to parachute to safety; now he was slammed to unconsciousness as the X-1A fell 51,000 feet in fifty-one seconds.

He will tell you today, that the X-1A was a 'real honest aeroplane', and there will be a faraway look in his eyes, which seem tired and older than his years,

reflecting something of the dangers and experiences that made him the fastest man in the world. He regained consciousness at 25,000 feet, to find the aircraft had settled itself into a slow, gentle glide in the desert air. Bruised, dazed, and dead tired, he was able to bring it in to a safe landing, with the help of his friend Kit Murray, who flew 'chase' in a Sabre-jet and guided him onto the runway that he could hardly see beneath the X-1A's long nose.

Just five days before the start of celebrations marking the fiftieth anniversary of the first flight by the Wright brothers he had flown at 2½ times the speed of sound. In half a century, the aeroplane had progressed from 7 m.p.h. to 1,650 m.p.h. and already there was another barrier to be overcome—the 'heat barrier' caused by the air friction that had made the X-1A's skin scorching hot although the outside air temperature was 60 degrees below zero.

This barrier, too, will be overcome by the genius of designers and the courage of pilots, just as every other natural barrier has been conquered—first gravity, then the narrow seas, the great oceans, mountains, the icy wastelands of the Antarctic and, most dreaded of all, the sound barrier. Already the Bell X-2 has been built to challenge the heat barrier at speeds over 2,000 m.p.h., and the X-15, ordered in 1955, is being designed to fly at 6,600 m.p.h. at heights up to a hundred miles above the Earth. The air it will fly in will be thinner than the finest vacuum that man can produce in a laboratory; and from the fringe of space its pilot will look out on the moon, planets, and stars, their brilliance undimmed by Earth's atmosphere. Then, distance too will cease to be a barrier, for it will be only a brief step from the X-15 to the space-ships which seem less fantastic to us today than did the aeroplane in the days when our grandfathers were at school.